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EXPANSION OF TECHNOLOGICAL AND TECHNICAL EDUCATION

MR. BOYD-CARPENTER'S written answer to questions in the House of Commons on January 29 regarding Government plans for the establishment of a technological university made it clear that the Government has no intention of establishing an entirely new institution of that type. Instead, it has decided to build on an existing foundation, and the decision to expand the Imperial College of Science and Technology in London to twice its present size has the advantage not merely of being less costly, but also of minimizing the difficulties and delays in assembling teaching staff of the high calibre essential. There is the further merit that the Imperial College already possesses a firm basis of prestige to which it will now be expected to add.

While the statement claims that this decision is in pursuance of the policy already announced by the Government and that the Government proposes also to make resources available for further developments in other parts of Great Britain, this claim must be firmly challenged. The Chancellor of the Exchequer has, it is true, already asked the University Grants Committee to advise him where such further resources might be most usefully deployed, but that the choice of the Imperial College comes seven months after Mr. Butler's announcement last June is suggestive of absence of a policy rather than pursuance of one. There is no indication as to what guidance has in the meantime been given to such claimants, for example, as the Royal Technical College, Glasgow, or the Manchester College of Technology, where considerable schemes of expansion are contemplated or in progress, nor is there any indication that the Government appreciates the importance of relating technological and technical education.

Perhaps the clearest proof that the Government has a policy for higher technological education would be an unequivocable announcement that the responsibility for it had been placed fairly and squarely on some one body, as the Advisory Council for Scientific Policy has already recommended. Apparently the Government proposes to use the University Grants Committee for that purpose; by according that body the *de jure* recognition in place of the merely *de facto* recognition it already enjoys, the Government could well establish the *bona fides* of its policy, and at the same time the position of the technical colleges at Glasgow and Manchester, both of which are already included in the returns from the University Grants Committee, might be resolved.

But the question what other institutions of higher technological education should be expanded is no more a matter for piecemeal decision than the choice just announced. The expansion of technological education in Great Britain must obviously be determined by the extent of the national resources, financial and material, as well as the man-power situation. It should equally be determined by a wide and clear view of national needs; and present concern

arises in part from the impression gained from a good deal of scattered evidence that neither the present Government nor its predecessor has had any such view.

The Government appears to accept the prevalent view that while Britain is pre-eminent in fundamental research she is lacking in its industrial application, and proposals to expand technological education are the immediate consequence. Any real policy to this end must, however, be concerned equally with the expansion of technical education, and with the effective use to be made of the new graduates in technology which the expansion of technological institutions would provide. There is as yet little evidence of an increased demand from British industry for their services as technologists, nor could their services as such be fully utilized without an appropriate expansion in the numbers of technicians, which are required in far greater numbers.

For this reason alone, a sound policy for the expansion of technological education can be framed only in line with one for the expansion of technical education. In the upgrading of technical colleges to provide them with the resources and the conditions of academic freedom that are essential for such work, the danger is not simply of spreading available resources too thinly. The effect on the resources for technical education must also be considered, quite apart from the question, on which differing views are held, as to whether technological and technical education can be given efficiently in the same institution.

Nor can it be assumed that the expansion of technological education is all that is required to provide Britain with the technologists she requires. As Dr. D. W. Hill pointed out in a recent article, a better distribution of the existing scientific personnel may provide a partial solution. Stress has been laid by the Advisory Council for Scientific Policy, as well as by Dr. R. L. Meier in an article, "Research as a Social Process", in the *British Journal of Sociology* (1951), on the lesser esteem which technological work enjoys in Great Britain. Attention to this factor, both in the schools and elsewhere, is undoubtedly required, whether or not it is necessary to make the financial rewards offered for technological work more attractive.

The point to which Dr. Hill directs more particular attention is the lesser use made of the technologist in high managerial positions in Great Britain compared with the United States. There it is customary for the executive heads of large industrial concerns to be technologists, particularly engineers. Dr. Hill notes that every president of the great Du Pont de Nemours concern since the First World War has been either a chemist or an engineer. Men so trained naturally attach high importance to the technological standards of their staff, and part of the problem of increasing the supply of technologists for Great Britain may well be to discover why the demand for them here is not more insistent.

There is a further reason why this requires consideration in elaborating a policy for technological education. Evidence has been provided in some of the productivity team reports of the Anglo-American Council on Productivity that leaders in British industry are not sufficiently receptive to technological advances. A large proportion of British industry consists of smaller firms which may not employ anyone competent to assess the significance for industrial development of new scientific or technological advance.

No matter what care is taken in the existing technological institutions of Great Britain and in their expansion to see that students are given the wide training that fits them to occupy ultimately high administrative positions, that of itself will not meet the difficulty of the smaller firm. A change of outlook on the part of industry generally is also likely to be required. How far government action could foster a change in the climate of opinion or encourage the wider spirit of adventure in industry for which Sir Henry Tizard pleaded in his Messel Memorial Lecture is a matter of opinion; but it is at least a factor of which the Government must take careful account in formulating a policy for technological education. Such a policy cannot bear its full fruits unless the Government does all in its power to remove hindrances or obstacles to enterprise, and to encourage the adventurous acceptance of the challenge of the times and the exploitation of new techniques and products and the discarding of outmoded methods and obsolete plant.

This aspect was not dealt with by Lord Halsbury when he reviewed the controversy over higher technological education in addressing the Institution of Chemical Engineers in Manchester on January 23. He agreed that the expansion of technological education meant limitation of resources available for other types of education and for other purposes, but he favoured a steady expansion of the technological faculties of our universities to an extent when the supply of technologists slightly exceeded supply. The surplus, he thought, would be absorbed in administrative positions; but it may be recalled that Prof. R. Peers, at a recent conference at Nottingham on industry and the universities, took a similar view regarding the absorption of arts graduates as administrators in industry.

There can be little doubt that the expansion of the universities, and especially the steady increase in the proportion of students receiving assistance in some way or other from public funds, has markedly affected the quality of direct recruitment from the schools to industry. Industry will perforce come to rely increasingly on entry from the universities to fill its managerial and more responsible positions; but it scarcely seems sound so to plan the expansion of higher technological education as to provide technologists in excess of a reasonable assessment of the demand for technologists as such. It is as implicit in much current discussion of university education as in the discussions on the content of technological education that training in institutions of that type should provide, not simply professional skill and knowledge, but first of all the capacity for clear and independent thought, the ability to tackle a problem, initiative and a sense of perspective and values, as

well as the readiness to accept responsibilities. These are the qualities which will determine the graduate's capacity to fulfil positions of responsibility in middle life and later, and they can be imparted as much on the arts side as on that of science and technology, provided the arts courses are attuned to the general problem of living in the technological society of to-day.

For that reason Lord Halsbury's suggestion appears to be unsound, and the expansion of technological education should be planned rather in accordance with factual requirements, so far as they can be ascertained. It does not appear that the Government has attempted any recent assessment of the real needs: that contained in Sir Ewart Smith's address at the British Association meeting in Birmingham in 1950 certainly should be taken further to provide a basis for policy. Some such quantitative estimate might provide one means of minimizing further controversy over the institutions to be selected for development, the scale of expansion and the types of technology to be included.

A very reasonable summary of the present situation and measure of agreement was given by Colonel B. H. Leeson in an address to the Institution of Electrical Engineers last October. He visualized the expansion of higher technological education as concentrated on a regional basis in a few selected larger colleges provided with first-class accommodation and staff, and stimulated by adequate opportunities and resources for research. The selected institutions would enjoy academic freedom under self-governing representative administration, and would not come under local education authorities. They would have facilities for postgraduate work, but would be expected to earn their prestige.

The small body which should be set up by the Government to select and to guide the colleges when chosen, in consultation with professional bodies, learned societies and industry, could well be a committee of the University Grants Committee; but until some such step has been taken the Government cannot claim to have a policy for technological education. It is emphatically not a matter primarily for the Minister of Education, though that Ministry will be required to renounce its authority over the selected colleges, and must also be concerned with the adjustments in the technical education that are involved. The technicians required, as Col. Leeson pointed out, outnumber the technologists by at least five to one, and whether or not the training of technicians and technologists can usefully and efficiently proceed side by side, at least in the selected institutions, the provision of facilities for training technicians will remain the responsibility of the Ministry of Education. Equally, the expansion of those facilities must match that of technological education. Parsimony or unwise retrenchment here could go far to thwart the expansion of technological education.

That due weight must be given to the content of technological education in planning its expansion, and especially to the exact technologies which are to be included, is indicated by the nature of the claims which have been advanced for the institution of new faculties such as pharmaceutical engineering science. Discussions at the conferences on industry and the universities, arranged by the Federation of British Industries, indicate that little support for such extravagances is likely to be forthcoming from the industrial side. That they should be advanced at all is a further reason for urging the early establishment of some agreed authority with the clear responsibility for encouraging the development of higher technological education.

Such a step in itself will not remove all difficulties in the way of co-ordination. While, for example, the Royal Technical College, Glasgow, has an independent board of governors and the local authority exercises no control, to develop further higher technological education there under the University Grants Committee would involve a transfer of responsibility from the Scottish Education Department. The position of another claimant, the College of Technology, Manchester, is more complicated. This includes the faculty of technology of the University of Manchester, and the College has received Government grants for more than forty years in the same way as other universities and university colleges. Nevertheless, the College is still subject to local authority control, though this need not perhaps be the main obstacle to its development as one of the few regional centres for the expansion of higher technological education. That obstacle is to be found rather in the limitations on its expansion placed by its equally important work in training technicians. The present plans for the expansion of the Manchester College of Technology contemplate the decentralization to subordinate centres of the more elementary work. This may give sufficient room for the development of the advanced work, and at the same time provision for part-time students from industry should minimize any drawbacks the partial divorce of technical from technological education might entail.

Quite apart, however, from the question whether it is wise to attempt to carry out technical and technological education side by side in the same institution, even when physical considerations such as siting do not impose limitations on expansion, the separation of technical and technological education should be determined on practical rather than on theoretical grounds, but in accordance with policy rather than by piecemeal decisions. Even on technical education the Minister of Education has given no signs as yet of having a policy, though formulation of policy is the first step towards the wise and efficient use of national resources. Such a policy must take account, not only of the balance between the numbers of technicians and technologists required by industry, of the probable demand for the services of both, of the resources and distribution of existing institutions, and the claims which expansion must make on available national resources; it must also take account of the well-attested gap which exists in Great Britain between pure and applied scientists and of the general impact of technology on society, and the stresses and needs which are liable to develop in consequence. Ultimately, it is concerned with the

rate of technological change and its general effects; and at a time when a prime reason for urging the expansion of technological education is to promote the economic development of Great Britain, it is the more important that heed should be given, in planning both our policy of technical education and its content, to the effects on society.

KINEMATIC RELATIVITY AND THE CREATOR

Modern Cosmology and the Christian Idea of God Being the Edward Cadbury Lectures in the University of Birmingham for 1950. By E. A. Milne. Pp. vii+160. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 21*s.* net.

THE late Prof. E. A. Milne had been asked to give a series of ten lectures on the Edward Cadbury Foundation at the University of Birmingham in the autumn and winter of 1950–51. The manuscript of these lectures was completed only a few days before his sudden death in September 1950, and the lectures are now published in book form, having been edited by his former pupil, Dr. G. J. Whitrow.

The original intention of the founder of the lectures was that they should be concerned with the relations, past, present and future, of Christianity to civilization and culture. Milne was invited to choose the relationship between cosmology and Christianity to-day. He states that he chose chiefly to discuss his own brand of cosmology because he had no faith in other theories of cosmology. The lectures, therefore, consist in the main of an exposition of kinematic relativity, which, being intended for a general audience, is practically free from mathematics. They provide the only exposition of this theory by Milne himself that can be described as non-technical. In the main, they cover the same ground as his book "Kinematic Relativity", but go beyond that work in giving an account of his last paper on a possible relation between gravitation and magnetism and a revision of his dynamical theory of light.

Kinematic relativity is a deductive theory which, starting from the cosmological principle in its narrow sense and from the basic facts of the dimensionality of space and time, and of the propagation of light, seeks to derive as much information as possible about the universe. The theory has been developed to cover not only cosmology but also a great part of theoretical physics. It employs two different time-scales: the so-called t-scale in which the relative motions of the observers are non-zero but unaccelerated, and the τ-scale in which the observers appear to be at rest. The zero of the t-scale, which is the instant at which the universe was created, corresponds to negative infinity on the τ-scale. The ordinary dynamical and physical laws employ τ-time, but the t-scale is regarded as the fundamental one. Though any statement involving one scale can be transformed into a statement involving the other, statements in τ-measure of anything but local phenomena are strange and unfamiliar. The τ-scale is an ephemeral one, only appropriate to epochs near the present epoch of the observer using it.

Milne considers that the universe started as a transcendental point singularity at $t = 0$. At that instant, the linear dimensions of all atoms, stars and galaxies of every type of configuration must have been zero. Thereupon expansion began, the motions being radially outwards; at any subsequent time the distance travelled by any given particle is proportional to its velocity. Kinematic relativity leads to a unique model universe; Milne argues that this uniqueness implies an absence of rational alternatives in creation and that this is a genuine argument for both the rationality and the oneness of God. He considers that the possibility of constructing a rational system of time-keeping by congruent clocks implies that the universe has been deliberately created.

Kinematic relativity requires the constant of gravitation and Planck's constant to increase proportionally to the age of the universe reckoned from the natural zero of time ($t = 0$). The inverse-square law of gravitation can be put into an invariant form only by those observers in uniform relative motion for whom identical world pictures present themselves. On this subject of gravitation Milne asserts that "The law of gravitation cannot have been created by God by an arbitrary fiat; it is a consequence of the disposition of matter and motion in the Universe, in our t-description. God is a geometer in the more extended sense of a mathematician who extends the geometry of static figures of points, lines, and planes to idealised particles in motion".

According to Milne's theory the number of galaxies is infinite, although the space occupied by them is finite. Thus as we get farther and farther from any one galaxy we cannot avoid getting near other galaxies. As the universe expands, it creates the space it needs. But there is no last galaxy; we can never reach the edge. The apparent density of the universe is everywhere finite, but it becomes arbitrarily large at an arbitrarily small distance inside the expanding frontier. The most swiftly receding galaxies will appear, owing to the slowing-down of their clocks, to have been created a very short time ago. Milne will have nothing to do with the concept of continuous creation on the ground that it offers no explanation of how the frames of motion, in which the hydrogen atoms appear sporadically, are created. Nor does he accept the theory of the heat-death of the universe, which was advocated by Eddington and Jeans. He does not regard it as an inevitable consequence of the second law of thermodynamics, when applied to the universe as a whole. It is not possible to make valid propositions about the entropy of all the bodies in the universe because the universe has no final state. "Near its inaccessible frontier, the world will appear ever young, though each individual member will be growing old. There is no need of any appeal to any principle of rejuvenescence. For the universe as a whole has no age and no size, only an age and a size when a particular observer is singled out, at a particular stage of his experience".

Milne considers the evolution of spiral nebulæ. He asserts that the kinematic theory of gravitation goes far towards explaining the spiral form of many of the galaxies; the spiral arms are a consequence of the secular increase of the constant of gravitation. He concludes that the whole course of the evolution of a galaxy is one of interchange of its members with other galaxies. There is an outward drift in the neighbourhood of each nucleus, and the particles are continuously accelerated until they momentarily reach the velocity of light; deceleration then sets in, and each particle eventually comes to rest near a distant

nucleus, becoming part of its galactic cloud of gas and dust particles. The galaxies are thus continually losing particles to distant galaxies but at the same time gaining particles from other distant galaxies. These particles when moving with speeds close to that of light are considered by Milne to constitute what we know as 'cosmic rays'.

Milne's discussion leads him to the following conclusions. "Laws of motion are not special creations but are indissolubly connected with the creation of the material content of the universe in the only manner in which such creation could have taken place, namely, by the recognition by the Creator of the impossibility of choosing special velocity frames when there is nothing to distinguish one frame from another, and of the impossibility of effecting the act of creation otherwise than at a point-singularity owing to the impossibility of choosing, unambiguously, simultaneous events separated from one another. Creation, the act, became a more and more difficult process the more we study it, until we see how God the Creator put aside the difficulties by the device of the creation of an infinite universe at a point as an initial point-singularity. . . . For the creation by God of an extended universe would require an impossibility, the impossibility of the fixation of simultaneity in the void—impossibility, that is, to a rational God. The paradox follows that the Deity himself, though in principle all-powerful, is yet limited by his very rationality. With God all things are not possible. This equally rules out the idea of continuous creation of matter everywhere in space, for there would have to be a pre-created space in which the creation of matter could take place; and there would exist a constant, namely the rate of creation of such matter, which could not be rationally accounted for."

Many readers of this exposition of kinematic relativity will not regard these conclusions as justified. But all will find much that is stimulating and thought-provoking in this exposition by its creator of a theory which has provided a searching examination of the concepts of time and space and which has great achievements to its credit. H. Spencer Jones

BOTANICAL TAXONOMY

Taxonomy of Vascular Plants

By Prof. George H. M. Lawrence. Pp. xiii+823. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1951.) 60*s*. net.

THERE has been a great need for an up-to-date and comprehensive handbook on the classification of vascular plants, and botanists all over the world are grateful to Prof. George Lawrence for undertaking to fill the gap. This he has done with notable judgment and skill, and with, inevitably, the expenditure of much time and labour that could no doubt be ill-spared from his research and other activities. As a result, he has produced a volume that will, for many years, be the daily companion of all concerned with the taxonomy of flowering plants and ferns.

The book is divided into two parts. The first, consisting of fourteen chapters (330 pages), deals with what may be broadly described as the principles and practice of systematic botany, while the second part (400 pages) is concerned with individual families, arranged in the sequence of Engler and Diels. There are two appendixes comprising a suggested syllabus for an elementary course in taxonomy, and an illustrated glossary of terms. An excellent single index completes the volume. Prof. Lawrence has chosen to scatter his very valuable bibliographies throughout the book after the relevant sections, and one thus misses the ease of finding a particular reference afforded by a single alphabetical bibliography, coupled with lists of abbreviated references after each chapter; but the saving of space no doubt dictated his choice, and, as it is, the bibliographies, especially those after each family in Part 2, will be one of the most welcome features of the book.

In Part 1 Prof. Lawrence gives excellent accounts of the history of botanical classification, leading to a survey of current systems, and has chapters on geographical distribution, nomenclature, identification, literature, field work and herbarium techniques, and on the writing of monographs, revisions and Floras. But it is probably to the sections on the more controversial aspects of taxonomy that many readers will turn first, for there are very few easily accessible recent summaries on the relationship between classification and phylogeny (Chapter 5), and on biosystematics and experimental taxonomy (Chapter 8). Prof. Lawrence's two chapters are undoubtedly the clearest and most up-to-date treatments so far produced, and show an awareness of many of the subtle difficulties that are so often ignored. In his discussions in phylogeny and taxonomy, however, and on biosystematics, one misses a clear statement of the basic aims of classification in general, and of biological classification in particular, without which the present troubled state of these subjects can scarcely be resolved. The idea that there can ultimately be one comprehensive classification of living things based on all their characters is a very attractive one to the human mind; but the belief that this concept is chimærical is slowly gaining ground, and a number of biologists are gradually realizing that, in common with all other types of object, animals and plants must be classified in different ways for different purposes. Against the background of this view, morphological, phylogenetic and 'biosystematic' classifications will be seen as systems existing in their own right, for their own particular purposes, rather than as stages towards the final goal of an all-embracing taxonomy of living things. It is to be hoped that, in future editions, Prof. Lawrence will carry his analysis one stage deeper and discuss more fully this borderland region between philosophy and biology.

In the second part of the book a clear and thorough account is given of all the important families of flowering plants and ferns, and, in addition, many other families are mentioned, under their orders, without description. The choice of the sequence of Engler and Diels, because "it is the only available system that has been devised to account in detail for the flora of the world", is a convenient and sensible one. Perhaps the most valuable feature under each order and family is the summary of the phyletic treatment given to it by various authors in the past—information not easily available elsewhere. The text figures illustrating each family add greatly to the usefulness of the descriptions.

Prof. Lawrence has produced one of the most important books for many years in the field of systematic botany, and it is to be hoped that, despite its inevitably high price, it will be widely bought and used by students. J. S. L. Gilmour

X-RAY CRYSTALLOGRAPHY IN TECHNOLOGY

X-Ray Crystallographic Technology

By André Guinier. English translation by T. L. Tippell; edited by Prof. Kathleen Lonsdale. Pp. xiii+330+16 plates. (London: Hilger and Watts, Ltd., 1952.) 56*s*. net.

THIS book was originally published in 1945 and was a good survey of X-ray crystallography as it was at that time. Since then, many developments have occurred which the author has not dealt with; however, the methods have not altered much, and the book forms a good introduction for the university student and research worker.

There are five parts and twelve chapters. The first three chapters are devoted to a study of the general properties of X-rays, the means of producing X-rays, and the theory of crystallography and X-ray diffraction. Chapters 4–6 are devoted to powder photographs, single-crystal photographs and the special applications of strictly monochromatic radiation. Chapters 7–9 deal with the determination of texture, chemical identification by measurement of cell dimensions, the study of phase diagrams and of elastic strains by accurate measurements of cell dimensions and, lastly, the study of order – disorder states in metals. The closing chapters, 10–12, deal with crystal imperfections, the diffraction of X-rays by amorphous substances, and the determination of the size of submicroscopic particles by low-angle scattering. The first appendix contains fundamental theory of X-ray diffraction too difficult to incorporate in the body of the text, and the succeeding appendixes give material such as tables of data about elements and the relation between θ-angles and the spacing for various wave-lengths which can also be found in the standard reference works. A number of plates are provided to illustrate various types of photographs referred to in the preceding chapters.

The book can be recommended as an introduction to the subject, although it is doubtful whether it will satisfy the needs of the technician, to whom the author specifically addresses the book. The omissions of subject-matter which might be expected in a modern book are no doubt partly due to the original time of its production, just after the Second World War, when there was much isolation of the scientific workers in France from those in Britain and other countries. It is almost certain that X-ray crystallographers need to know much more about high-temperature powder cameras, about moving-film cameras of various types, and more about spectrometers and Geiger counters than is here included. The actual description of instruments is, with only one or two exceptions, confined to the principles on which they are constructed. The technician usually requires to know the merits and demerits of various types, and even how to modify a given type to suit his particular purpose. The treatment given here is too brief and too academic really to serve the technician, though it will be useful to students in general.

There is one innovation which seems unfortunate to me—namely, the introduction of the term 'crystal base' to signify the nature and arrangement of the contents of a unit cell of the crystal. In the German literature '*basis*' is firmly established as the correct word; but in English writing 'basis' has only occasionally been used and usually the word 'structure' serves. A possible objection to the use of the word 'structure' is that it also signifies the nature and arrangement of the atoms in the whole crystal, though this ambiguity is not usually a serious difficulty. There are, however, weighty objections to the use of the word 'base'. It has the ordinary meaning of 'lower surface', and if the term 'base' is introduced, as in this book, it will be necessary, for example, to make a confusing statement such as "the base of sodium chloride contains four sodium and four chlorine atoms". Further, the plane (001) is invariably referred to as the 'basal plane', and hence the 'base' in morphology means this plane. If the term 'crystal structure' is not adequate, perhaps 'unit-structure', 'cell-structure' or 'cell-assembly' might be used.

The production of the text, tables and photographs is excellent, and there appear to be few misprints.

W. A. Wooster

PSYCHOPATHOLOGY OF GENIUS

The Infirmities of Genius

By Dr. W. R. Bett. (Medical Viewpoint Series.) Pp. 182+6 plates. (London: Christopher Johnson (Publishers), Ltd., 1952.) 18*s*. net.

IN this book, parts of which have already appeared in *Clinical Excerpts*, Dr. W. R. Bett sets out to describe briefly the lives of fifteen men of genius and to relate their mental activity to the various afflictions which beset them. Beginning with Carlyle, whose neurasthenia he attributes to dyspepsia, he proceeds to discuss, among others, Shelley, Whitman, Swinburne, Baudelaire, Burns, Byron, Pope and Lafcadio Hearn. In every case he shows that there can be little doubt that the maladies from which his subjects suffered influenced their literary output and their relation to the society in which they lived. This is what would be expected, and Dr. Bett's treatment of his cases is too slight to enable the reader to consider the much more difficult problem of the precise relation that genius itself bears to the medical history of each individual.

There is no doubt that the literary output of such persons as Byron, Pope or Baudelaire was highly coloured by their infirmities; but these misfortunes were merely those which affect many others and which are clearly not related to genius itself. What is more probable is that the man of genius is likely to suffer from psychosomatic complaints which arise from the very fact of his genius setting him somewhat apart from his fellows; and, indeed, the examples chosen by Dr. Bett would seem to some to suggest this, although the cruder physical deformities naturally played their part in moulding the general attitude of those suffering from them.

What has to be distinguished is genius itself (whatever this may be) and the results of that genius as seen in literary and artistic production. How far such production proceeds purely from the conscious mind or is related to subliminal processes engendered by alcohol or drugs, as seems to have been the case with De Quincey and Coleridge, we do not know. It seems clear from Dr. Bett's intriguing study that, in the cases he cites, genius, although at times hampered and restrained, was able to surmount infirmity and add much without which the world would be considerably the poorer.

E. J. Dingwall

A Manual on the Weeds of the Major Crops of Ceylon

Prepared by a Committee consisting of Dr. J. C. Haigh and representatives of the Tea, Rubber and Coconut Research Institutes. (Department of Agriculture, Ceylon: Peradeniya Manual No. 7.) Pp. iii+50+vi+50 plates. (Colombo: Ceylon Government Press, 1951.) 5 rupees.

THIS work is perhaps better described as an annotated atlas rather than a manual, since its chief feature is the set of coloured plates of fifty of the commonest weeds of Ceylon, which admirably portray their habits and also exhibit some details of the reproductive organs. The accompanying text is comparatively brief and provides botanical and native names with short notes on habit, habitats, flowering time and flower colour, modes of propagation, a few descriptive details and mention of uses and means of control. The whole atlas is contained in a loose-leaf cover so that, as the promised supplements appear, the plates can be rearranged in alphabetical order.

It is interesting to note, in this half-century of common weeds, how few would appear to be regarded as definite pests, and many appear to provide useful vegetation-cover for the soil. One notes that the eradication of two species of *Oxalis* is described as impracticable. The perennial grass, *Imperata cylindrica*, evidently plays the part of a tropical couch grass, while the recently introduced annual grass, *Cenchrus echinatus*, has spread to an extent that is causing concern. A dwarf vegetatively propagated variety of the mugwort, *Artemisia vulgaris*, appears to be a greater nuisance than the taller type, which is propagated mainly by seed.

One can look forward to the supplements that are to appear in due course, and the whole should make a valuable addition to the bibliography of the weed flora of Ceylon. E. J. SALISBURY

The Subject Index to Periodicals, 1951

Issued by the Library Association. Pp. xi+313. (London: Library Association, 1952.) £5 5*s*. 0*d*.

THIS index maintains the high standard of production characterizing the earlier volumes and, although now limited to publications in English which are issued in the British Commonwealth, provides the general reader with a key to the contents of many periodicals which are not indexed elsewhere. United States and Canadian periodicals are excluded only because they are adequately covered by the indexes of the H. W. Wilson Co. Highly specialized periodicals in the fields of science and technology are also omitted, because they are mostly indexed or abstracted by the societies and institutions concerned; but the scientific worker and technologist will nevertheless find this index a very useful key to general discussions, in the responsible monthly reviews as well as in scientific and technical periodicals, of such questions as technological education, industrial research, broadcasting, science and society, and the like. The 'proceedings' and 'transactions' of many local societies concerned with archæology, natural history, etc., are covered. The compilation is done on the plan of the 'dictionary catalogue', all entries being arranged under black-letter headings in a single alphabetical order. While cross-references are freely used to link up related subjects and direct attention to unusual, out-of-the-way topics which would otherwise be overlooked, one weakness has been noticed in the referencing from the general to the particular: the referencing under particular countries has made it rather difficult to determine the extent to which this index covers the more general current discussion of Colonial development and welfare or economic assistance of backward areas, whether under United States Point Four Aid or otherwise.

Sound Recording and Reproduction

By J. W. Godfrey and S. W. Amos. (BBC Engineering Training Manuals.) (Published for *Wireless World*.) Pp. 271+10 plates. (London: Iliffe and Sons, Ltd., 1952.) 30*s*. net.

ALTHOUGH this book has been written primarily as an instruction manual for the use of the engineering staff of the British Broadcasting Corporation, it cannot fail to be of interest to all who are engaged in the techniques of sound recording and reproduction. The equipment described is, quite naturally, mainly that used by the B.B.C., but the principles dealt with concern not only engineers but also those students who are interested chiefly in the academic side of this subject of ever-growing importance.

The first chapter deals with the general principles involved in recording and reproduction, and thereafter the book follows a logical order, dealing comprehensively, though of course not exhaustively, with disk recording, magnetic recording and reproduction and, finally, recording on film. For those requiring data for reference purposes, there are a number of useful appendixes, and to help those who need still further information, a list of references is given.

Throughout the book the text is assisted by many excellent photographs, diagrams and graphs, and altogether the book makes very good reading. As the B.B.C. is now one of the largest users of recorded material in the world and has developed equipment of a very high standard, it does seem that such a book as this is really necessary, and it should receive a hearty welcome, especially by the staff in training.

An English Course

For Royal Society of Arts and Technical Students. By Stanley Day and S. H. Wiltshire. Pp. 164. (London: Macdonald and Co. (Publishers), Ltd., 1952.) 7*s*. 6*d*. net.

THIS is an excellent little book. It covers more ground than does Sir Ernest Gower's "Plain Words", it is more systematic and it does not fall into the pits about which it warns others. It is succinct but not scrappy, logically developed with interesting and adequate exercises, and delicately spiced with a gentle humour. The book would do a good work in fields besides those of English courses for Royal Society of Arts and technical students for which it is primarily intended. It would solve many of the problems of expression which are met by science workers who have to convey their meanings by using the English language.

Many science students who need a little French and German would derive much benefit by taking this course in their mother tongue as an aid to their studies in other languages. A simple, direct English style which avoids ambiguity and circumlocution is the key to good science-writing, and this is the aim of the authors. An appendix gives a very useful list of books, including drama, novels, and poetry for the extended reading of the student. There is a good section on précis-writing. W. L. SUMNER

PRODUCTION AND USES OF RADIOISOTOPES*

By Dr. HENRY SELIGMAN
Atomic Energy Research Establishment, Harwell

BEFORE the War one could make materials artificially radioactive by bombardment in big machines like cyclotrons, or by using relatively weak neutron sources. In the cyclotron, one can generally only use one target at a time and the irradiation is therefore costly. The weak neutron sources induce only weak activities. Therefore only a few research workers profited from the radioisotopes which one could produce in these ways.

The situation changed suddenly with the discovery of fission of uranium in 1939. This discovery showed that chain reactions were possible in which more neutrons are created than used. Accelerated by war research, the first chain-reacting atomic pile was working on December 2, 1942, in Chicago. Since 1947 we have had a pile working in Great Britain, and since early 1949 we have had a bigger reactor, BEPO, in full operation.

Such a conventional atomic reactor consists of fissionable material, like uranium metal, and a moderator like, for example, graphite or heavy water. The British piles use graphite as moderator. With the construction of such piles most formidable sources of neutrons were made available, which can be used for the bombardment of nuclei in order to make them radioactive. The great advantage is that in such a reactor a large quantity of material can be made radioactive at the same time. Since 1949, radioactive isotopes, of great specific activity, have been readily available in Great Britain.

New radioisotopes were quickly discovered and the chart of radioactive isotopes started to expand. To-day, there are more than six hundred radioactive isotopes, of which, however, only some hundred can be made conveniently in an atomic pile. For most elements there is at least one usable radioactive isotope. The only notable exceptions are the two elements nitrogen and oxygen for which no convenient radioactive isotope exists.

The process of irradiation is extremely simple. The material to be irradiated is put in a container and then inserted into the pile. After a certain time it is retracted, and either chemically processed or sent direct to the user.

There are a few points which are of importance. The neutron flux varies in the pile from place to place, and has to be carefully measured if one wants to get the right activity for each sample. The second important factor is that one has to observe the self-shielding of highly absorbing materials like gold or cobalt. The specific activity is a function of nuclear data, such as half-life, excitation cross-section for neutrons as well as irradiation time and neutron flux. The neutron flux in the isotope production pile at Harwell is greater than 10^{12} neutrons/cm.^{2}/sec.; but even this very high flux is, in some cases, not enough to produce a high specific activity for the purposes for which the isotopes are wanted in industry, research or medicine, and in some cases special preparations have to be made in order to eliminate the non-radioactive isotopes. This is usually done by a chemical process, when the isotope produced is chemically different from the other atoms. One such process is the n,γ-reaction followed by a β-decay, of which the production of iodine-131 from irradiated tellurium is a good example. A number of neutron-proton reactions occur easily in the pile, and the production of carbon-14 from nitrogen-14 and phosphorus-32 from sulphur-32 are the most important of these applied reactions. Tritium is extracted from irradiated lithium after an n, α-reaction. Fission products can be separated either on ion-exchange columns or by co-precipitation methods. Szilard–Chalmers reactions are used, especially in the preparation of carrier-free radioiron, for which potassium ferrocyanide is irradiated. In all these cases extensive radiochemical preparations have to be made and sometimes the extraction procedures involve only between 10^{-9} and 10^{-12} gm. of material. Quite a number of syntheses, mainly of organic compounds, have been made by the Radiochemical Centre at Amersham, which is an out-station of Harwell.

Radioisotopes are useful for three reasons. The first is the very great sensitivity in detecting the smallest amounts of active material. If we compare the sensitivity with orthodox methods, for example, spectroscopy, we find that in many cases, if not all, it is much better. The limits of detection in spectroscopy are usually between 10^{-7} and 10^{-9} gm. Some of the carrier-free radioisotopes can be detected up to 10^{-16} gm.; but even if the material is not carrier-free, a sensitivity of 10^{-10} and 10^{-12} gm. is quite usual, and shows that isotopes are superior to orthodox methods of analysis by anything between a thousand and a thousand million times. Therefore, rightly, the application of these new tools to science has been compared with the discovery of the microscope. Another similarity with the microscope lies in the fact that it is possible to locate these small traces without damaging the material, whereas with chemical methods, when testing trace amounts, the material is either destroyed or dislocated. It is this possibility of locating the trace elements which is so important in research and industry. The third big class of applications is the use of the beta- and gamma-radiations emitted from radioisotopes. They are used for ionizing air in order to make it conductive for electricity, for penetrating materials for the purpose of making radiographs or for destroying tissue or blood corpuscles.

Industry has made use of the sensitivity of the method in tracing underground currents of water. For this purpose one can use tritiated water; although the beta-radiation from tritium is rather weak, with modern methods of detection very small traces of this material can be measured. The advantage of using tritiated water is that there is no danger of ion adsorption on soil that would occur with most other ions. In the oil industry, it is frequently necessary to mark the interphase between two oils pumped through the same pipe-line. Indeed, it is becoming a routine method of detection to add a radioactive isotope to indicate when a different oil is coming through a pipe-line at a distant location.

Leaks in water mains and pressurized cables have been detected successfully by adding small amounts of radioactive materials to either the water or the gas in the pressurized cables. In France, a method has been developed for using methyl bromide in which the bromine is radioactive. This is injected into the

* Substance of a Friday Evening Discourse at the Royal Institution on February 6.

gas of the pressurized cables; if it leaks out into the ground, the methyl bromide remains in the soil and can therefore be easily detected hours later by monitoring on the surface with simple detection instruments. All these applications of radioisotopes enable us to carry out operations which would be very difficult to do by any other method.

We are frequently called upon to make ventilation experiments in factories or assembly rooms. Here we use radioactive vapours or gases. Ethylene-dibromide has been used successfully, but will eventually be replaced by noble gases like krypton-85 or xenon-133, when they become available in the near future. Great care has to be taken that these gases are not adsorbed on walls or machines, and therefore noble gases are more suitable than radioactive vapours.

Isotopes can also be used in problems of mixing. The problem may be to find when the mixing process is complete between small amounts of material like vitamins and large amounts of other foodstuffs. By adding a small amount of harmless short-lived radioisotope, the mixing can be controlled and checked when the material is transferred to the conveyor belt.

A thickness gauge has been developed which works by attenuation of radiation by the material. Another system of measuring the thickness of the coating of materials makes use of the reflexion of beta-rays. The reflexion depends on the atomic number and the thickness of the reflecting material, and can be used to measure the thickness of one material on another, where the two materials have different atomic numbers.

The discharge of electrostatic electricity produced during a manufacturing process which entails rolling insulating material like plastic, rubber, paper, etc., is often a great problem to industry. Dust particles are, for example, attracted to the fabrics in weaving nylon or rayon when they are left in the looms overnight. In some cases one can neutralize the static charges by ionizing the air with a radioactive source giving beta-radiation such as thallium-204.

The ionization from radioisotopes can also be used to help in starting gas discharges. A gas discharge can only start if a free electron is present. The presence of beta-emitting isotopes makes the starting operations more reliable and is being used to promote ignition at spark gaps and to make cold cathode ray tubes work more smoothly.

In process control, radioisotopes have been used successfully in the operation of ion-exchange columns. Thus, radioactive sodium ions are kept back by a resin and the radiosodium can afterwards be dissolved out under controlled conditions. This method is used in the separation of zirconium and hafnium by adding a small amount of radiozirconium and radiohafnium, which are retained in the column. One can find out when the column is saturated by measuring the activity at the bottom of the column; the washing-out agent for one material is then added, and when this one is totally dissolved, which again is checked by activity measurements, the second washing-out agent is added. It is a remarkably easy way of ensuring a constant accurate analytical control.

An important use of radioactive sources is for gamma-radiography. Isotopes have a number of advantages over X-ray equipment. They are less cumbersome. A 2- or 4-mm. cylinder can be used for insertion into a small pipe, for example, or for taking radiographs under water. By this means welds, for example, in the shipbuilding industry can be tested. Radiographs can be made in the field, as no electrical supplies are necessary, and lastly, these gamma-sources need no maintenance. The main disadvantage is that the exposure-times necessary at present are relatively long; but this disadvantage will become less and less serious as sources of higher specific activities become available. Three isotopes are available for gamma-radiography, depending on the purpose needed. Cobalt-60 emits on average 1·2-MeV. gamma-rays, which can be used for making radiographs of 2–6 in. of steel; iridium-192 emits gamma-rays of 0·6 MeV. and can be used for investigating thicknesses of steel $\frac{1}{2}$–2 in.; and thallium-170 with 80-KeV. gamma-radiation can be used for radiography of light alloys. Industry in all countries is already making extensive use of these sources.

Much use has been made of isotopes in metallurgy for measurements of self-diffusion, especially by following the movements of molecules under heat treatment. The measurement of wear of metals becomes easy by making one part of the metal radioactive. Thus, the wear of piston rings in an engine can be determined by making them radioactive and measuring the activity on the cylinder walls and in the lubricating oil.

In physical chemistry, labelled catalysts have been used to demonstrate their part in chemical reactions, and small vapour pressures of different materials have also been measured. The passage of water through membranes or 'Cellophane' has been accurately determined by using tritiated water.

Activation analysis is being used, especially in cases where the normal methods of chemistry fail. A special advantage is the localization of trace amounts. In France, use was recently made of activation analysis in establishing evidence in a murder case. A man had been poisoned with arsenic; but difficulty arose in finding out when arsenic was first administered to him. Arsenic accumulates very quickly in the hair after administration, and, having a high activation cross-section, becomes very radioactive by pile irradiation, whereas the normal components of hair are scarcely affected. Therefore, by irradiating a hair of the poisoned victim in the French pile and making an autoradiograph of the hair afterwards, the time could be established when the arsenic was administered, since the rate of growth of hair is known. Industry is making use of activation analysis in, for example, the determination of impurities of arsenic in germanium for the electrical industry, where one can determine 0·01 parts per million. Traces of copper have been accurately measured in the manufacture of rubber, where copper has a very adverse effect.

The uptake of phosphorus in plants has been determined by using radioactive phosphorus. Such experiments were made in order to find the best fertilizing conditions, and, in fact, it is the only method of distinguishing between the phosphorus taken by plants out of the ground and that given as fertilizer. It is claimed that this investigation has made possible considerable savings by demonstrating the optimum fertilizing conditions.

In zoology, radioisotopes have been used as tracers to follow animals underground.

Great progress has been made in biochemistry. Quite a number of metabolism studies have been made which would be difficult, if not impossible, without the help of isotopes. The protein and plasma

protein metabolism have been investigated, using carbon-14 amino-acids. Penicillin has been made active and its reaction has been followed in animals.

The future will see an expansion of the use of radioactive materials as bigger sources are used for irradiation purposes. At the moment work is in hand in examining chemical synthesis or changes happening under very strong radiations. At the same time, some progress has been made in trying to sterilize foods and penicillin by radiation. The dosages necessary for this are very big indeed. They are of the order of a hundred thousand or millions of roentgens, and in Great Britain it will be another year or two before facilities are available for this kind of research.

The Atomic Energy Research Establishment at Harwell and the Radiochemical Centre at Amersham are sending out more than nine thousand shipments of radioactive materials a year to some thirty-seven countries, including the United States, most South American countries, Africa, India, Australia and New Zealand. The majority are used in medical research, diagnosis and therapy.

In medical diagnosis very small amounts of activity are required and have been used successfully for blood circulation tests. Work is in hand in tracing tumours of the brain by tracer methods. In therapy, the greatest use is that made of radio-iodine in the treatment of thyroid toxicosis. Some cases of thyroid cancer can be treated successfully with radioiodine. Cancer of the bladder can be treated with an active bromine solution in a rubber balloon. Colloidal gold is used as a palliative treatment of malignant pleural and peritoneal effusions. Radiosodium is used in plastic surgery. Radio-phosphorus is used in polycythæmia vera. Big telecurie sources are used for general irradiation, and special beta-sources which only penetrate a few millimetres of skin are used in the treatment of some surface cancers. These are usually applied as radio-phosphorus built into a plastic. The plastic is irradiated in the pile and, after irradiation, the radiotherapist cuts out the right shape of the plastic which he needs and applies it to the malignant tissue, leaving it a calculated time in order to give the exact radiation dosage.

In the early post-war days, people were apt to speak of isotopes as 'by-products' of atomic piles. This picture has changed now. Radioisotopes have helped industry in solving many problems, they have widened the field of research in many sciences and have helped the medical man to treat disease and, in some cases, to save life. They have become an important part of the atomic energy development, and I am convinced that we are only at the beginning of the development of 'isotopics'.

THE NATURE CONSERVANCY

SOME aspects of the work of the Nature Conservancy were the subject of discussion at a meeting of the Linnean Society on February 19. In his opening remarks, Captain C. Diver said that conservation and research, the Conservancy's two main functions, are necessarily very closely linked. He and Dr. Conway dealt with two ways by which scientifically valuable places might be safeguarded for study; Mr. Skellam and Dr. Ovington, who are each in charge of one of the half-dozen main research programmes now being carried out by the Conservancy, then outlined one or two of the problems on which they have been working.

The most effective means of conserving any special place is to acquire it or otherwise arrange for it to be managed as a Nature reserve. This is not always easy because of land requirements for forestry, agriculture, service training, and development of one kind or another. To exemplify these conflicting demands, twelve cases were mentioned where places of the highest scientific value have been lost or threatened; these included the requirement of Bilston Glen for dumping colliery spoil and the Arne heaths in Dorset for ball-clay working.

The Conservancy has, however, already declared nine reserves (two in Scotland and seven in England) totalling about 22,000 acres; and negotiations are proceeding satisfactorily in respect of at least seventeen more. Informal agreements have also been made with the owners of several other properties; and help is being given with the management of a few sites already held as reserves by other bodies. Two local authorities are using their new powers to establish local reserves.

The Conservancy has also acquired two properties —one in the Lake District and one in Dorset—which are being equipped as research stations; and field research facilities are being provided at Moor House Reserve (Westmorland) and at Beinn Eighe Reserve (Wester Ross).

Dr. V. M. Conway said that the making of Nature reserves can safeguard only a small fraction of the wild country that must be kept in something like its present state if reasonable stocks of the native flora and fauna are to be preserved. Power to conserve other interesting places rests largely with local authorities; but under Section 23 of the National Parks and Access to the Countryside Act, 1949, the Conservancy has the duty of notifying planning authorities about the areas which are of special scientific interest by reason of their flora and fauna, or geological or physiographical features. Local planning authorities are required to consult the Conservancy before giving planning permission for developments likely to affect areas so notified. The Conservancy can then put the scientific case for conservation, and can approach owners and other interested parties. One of the weaknesses of this arrangement is that changes in sylvicultural or agricultural methods do not constitute 'development' and might, therefore, occur without the Conservancy's knowledge, often to the detriment of the valuable characteristics of the area.

The choice of areas for notification under Section 23 rests primarily on the recommendations of the local committees of the Nature Reserves Investigation Committee which was at work during the War. These recommendations have been checked and revised since the Conservancy came into being in 1949—work which has been made possible only by a large amount of voluntary help. Notifications must be made with minimum delay because so many good places are being lost all the time, and planning authorities need information as quickly as possible. For this reason there are many gaps and inequalities in the existing lists; but by careful collection of information over the next four or five years it is hoped that these may be largely removed in time for the first revision of county development plans.

Passing from administration to research, Mr. J. G. Skellam said that the statistical analysis of observa-

tional data enters into all aspects of the Conservancy's scientific work. In order to illustrate the mathematical approach, he selected just one topic, that of quadrat sampling. This subject is of considerable importance to the Conservancy because of the need to assess floristic and faunistic changes which may be taking place in the same locality with the passage of time and to measure the differences which exist from place to place; and in both cases to do so with known accuracy.

Mathematics can be applied to biological problems in two ways. In the first place, mathematical functions can be used for describing numerical results in a concise way. But such descriptions are often arbitrary and only acquire meaning when they can be related to the underlying causes. It is instructive in this connexion to construct simple models or idealized versions of the biological situation as suggested by observation and experiment and to deduce their consequences. In this way we not only discover functions which are suitable for description of numerical data, but we also construct standards which play the part of a basis for comparison against which the real complexities may be critically demonstrated.

Dr. J. D. Ovington then briefly described some of the woodland research carried out by the Conservancy over the past three years in co-operation with the Forestry Commission. Investigations are progressing at several widely different localities in Great Britain. Each locality contains a number of woodland plots of different tree species established on what were originally fairly uniform sites. The principal characteristics of the various woodlands and their dynamic relationships are being considered with particular reference to the climate, soil and ground flora. Tree canopies intercept precipitation and in so doing diminish and redistribute the rainfall reaching the soil. The irregular distribution of the precipitation pattern in woodlands can in part be attributed to the raindrops coalescing on the canopy and falling as large drops. Once established, the trees influence soil formation, and, after twenty years of afforestation, marked differences, particularly in the accumulation of surface organic material, soil *p*H and nutrient content, develop under different tree stands. The weight of the ground flora present in a woodland may be related to the age and closeness of the trees and to the type of woodland that has been established. The associated woodland floras differ considerably in their floristic composition and give some indication of the extent to which site conditions have been modified by the various woodland plantations.

Discussing Dr. Ovington's paper, Dr. J. Ramsbottom directed attention to the importance and specificity of the fungal flora in different types of woodland—facts which are frequently overlooked. Dr. Ovington confirmed that the species of fungi present in the plots he has worked on show differences like those described by Dr. Ramsbottom, and he thinks it is of primary importance to understand the part played by these species in the nutrient cycles. Replying to Mr. W. T. Stearn, he explained the technique used for measuring the size and dispersal of raindrops.

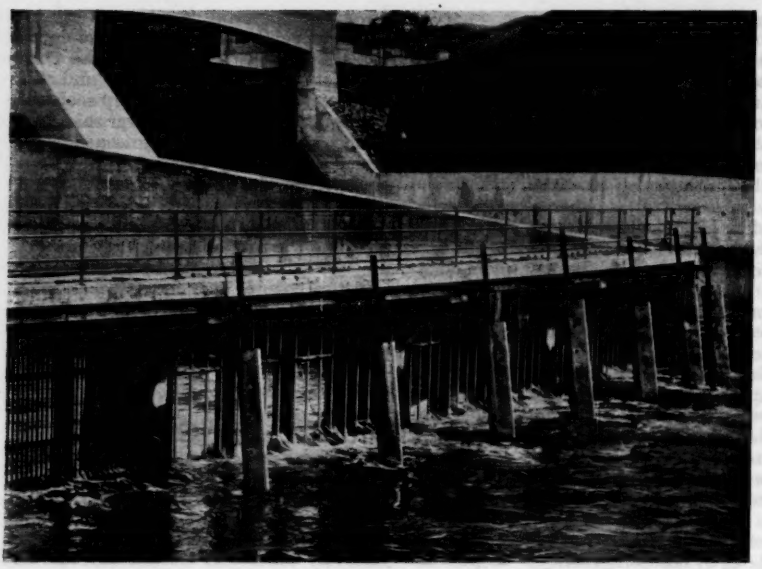
Speaking of the Midlands, Dr. A. Tindell Hopwood said some useful work might be done on the covering of slag-heaps with vegetation. Dr. Conway replied that one of the research students supported by the Conservancy is already working on this problem and that the Conservancy might take a direct interest in it when it has made sufficient headway with its primary task of conserving unspoilt areas of land. Prof. C. T. Ingold expressed the hope that the Conservancy will not get too departmentalized and will keep in close touch with local natural history societies and possibly issue a journal. Captain Diver said that he expected regular reports will now be issued. Mr. Stearn pointed out that many places are not in a static condition but are changing all the time, and asked what will be done about this. Captain Diver replied that when places are considered for reservation it is essential to know whether one wants to maintain them in a particular phase, for example, downland turf, or to study the natural sequence of change as in a prograding coast; and reserve management policy has to be directed to achieve the required result.

ELECTRICAL DEVICES FOR CONTROLLING THE MOVEMENTS OF ANADROMOUS FISH

INCREASING attention has been paid, over the past few years, to the use of electric currents as aids for catching fish in freshwaters, and it is evident that the use of electrical methods promises to become an important technique both for the fisheries biologist who wants to carry out census work and the owner who wants to reduce or eliminate populations of unwanted fish from his waters.

A recent communication[1] by a member of the staff of the North of Scotland Hydro-Electric Board has described other uses of electric currents in fisheries. Hydro-electric works are bound to have important effects on the movements of migratory fish, since they frequently interpose barriers to migration or create other unnatural hazards in the course of their operation. Over much of the area covered by the North of Scotland Hydro-Electric Board, salmon are the most important migratory fish, and it has been found necessary to try to discover ways in which the potentially deleterious effects of hydro-electric developments could be minimized. When constructing impounding dams, the Hydro-Electric Board is legally bound to provide fish ladders so that migrating fish can pass upstream or downstream; but the construction of hydro-electric power stations creates other problems. Downstream migrants may be drawn into the tunnels or aqueducts which lead to the turbines, and the volume and turbulence of the water discharged in the tailrace from the stations may deflect migrants from their course and so interfere with their passage upstream. In the communication mentioned, an account was given of devices which are being used for trying to solve both these problems, following experimental work in the Board's laboratory at Dundee.

At Morar, an electric screen has been erected to deter salmon and sea trout from entering the tailrace of the power station. This screen consists of a row of aluminium electrodes, each about 14 ft. in length, which extends to three inches from the bottom of the channel, together with two electrodes, about 16 ft. apart, placed 7 ft. downstream from the main screen. A pulsating electric supply is applied across the electrodes. Salmon are seen to react when about 5–6 ft. from the outer electrodes since, at this distance, they turn and swim upstream past the end of the



Experimental screens at the Power Station, Pitlochry (Perthshire)

tailrace. Reactions are seen in sea trout when they are about 2–4 ft. (depending on their size) from the inner row of electrodes. Experimental work with this screen was first carried out in 1950, was repeated in 1951 and again repeated, with improved electrical equipment, during the spring of 1952. During the last period, constant observation was maintained on the movements of fish. No fish were seen to penetrate far into the tailrace, and all the fish seemed to behave normally after leaving the electrified zone; no signs of distress were seen and there was no inclination to remain inactive.

The success of this screen at Morar has led to the installation of similar screens at other sites. The accompanying photograph shows a screen which has recently been set up on the tailrace from the power station at Pitlochry, which is situated at the lower end of Loch Faskally.

Experiments on the use of electric screens to divert descending salmon smolts have been carried out, over the past three years, at Dunalastair Dam on the River Tummel in Perthshire. Here the screen consists of two parallel rows of aluminium tubes strung diagonally across the lower end of Dunalastair Reservoir immediately above the dam. The downstream row is made up of 272 tubes one foot apart, and the upstream row, which lies 6 ft. from the downstream row, consists of 34 groups of tubes spaced at 8-ft. intervals. As at Morar, a pulsed current is applied across the screen. The purpose of this screen is to divert the downstream-migrating smolts from the entrance to the aqueduct, which conveys water from the reservoir to the power station at Tummel Bridge, into the fish pass. Though this device has not been so successful as the tailrace screen at Morar, it has shown sufficient promise to warrant a continuation of this experiment.

As well as carrying out tests on the use of electric screens, the North of Scotland Hydro-Electric Board has also devised an automatic electrical counter which has been installed in the fish ladders at Clunie and Pitlochry Dams. Its operation depends upon the difference in resistance to electrical currents between a salmon or sea trout and the water in which it is swimming; the passage of a fish through the submerged pipe linking two chambers of the fish pass can thus influence an electrical bridge, and this disturbance can be made to work a counter. The apparatus can be adjusted so that only fish greater than a certain size are counted, and refinements make it possible to operate this equipment in waters of widely varying chemical content. The passage of salmon upstream and the passage of kelts downstream are recorded separately; but if a fish does not complete its journey through the pipe, its passage is not recorded. Branches of trees, logs of wood, empty tins and other debris passing down the fish pass do not affect the counter. This equipment was in operation at Pitlochry during 1952, and daily checks have shown the electrical counter to have an accuracy approaching 100 per cent.

The future development of all these devices will be followed with great interest by all who are concerned, professionally or privately, with the welfare of salmon fisheries. The importance of the electric fish screens needs no emphasis, and the counter, though it plays no part in controlling the movements of migratory fish, should produce records the value of which will increase as the years pass. It is to be hoped that the fullest possible records will also be kept of environmental conditions, since in these circumstances the records from the electric counter could prove valuable additions to what is known of the characteristics of the upstream migration of salmon.

[1] Lethlean, N. G., "An Investigation into the Design and Performance of Electric Fish-screens and Electric Fish-counters", paper presented to the Royal Society of Edinburgh on February 2, 1953.

OBITUARIES

Prof. G. D. Hale Carpenter, M.B.E.

Geoffrey Douglas Hale Carpenter, professor emeritus of zoology (entomology) in the University of Oxford, died at the Radcliffe Infirmary on January 30 at the age of seventy. He came of a distinguished academic family and was a grandson of William Benjamin Carpenter, F.R.S., one of the most eminent physiologists of his time. His father was an assistant master at Eton, and his mother the daughter of another; but although born in the College itself his early education was received at the Dragon School and Bradfield. He then passed to St. Catherine's, Oxford, where he took his B.A. in 1904, obtaining second-class honours. Throughout this period he took a wide interest in natural history, and especially ornithology, conchology and entomology, so laying

firm foundations for his future career. His first paper was an unpublished one on the mother-of-pearl moth (*Sylepta ruralis* Scop.) and its parasites which he read, while still an undergraduate, to the Ashmolean Natural History Society of Oxfordshire, one of the many societies of which he later became president, and which he always regarded with much affection. From Oxford he passed with a University Entrance Scholarship to St. George's Hospital, London, qualifying M.R.C.S., L.R.C.P., taking the degrees of B.M. and B.Ch. in 1908, and eventually holding the appointments of house-surgeon and house-physician.

Hale Carpenter's interest in entomology led him to specialize in insect-borne diseases, and in 1910 he entered the Colonial Medical Service. The following year found him in the Sesse Islands in the north-west part of Victoria Nyanza, where he had been sent to study the bionomics of the tsetse fly, *Glossina palpalis*, which had recently appeared in Uganda and within a few years had caused more than two hundred thousand deaths from sleeping sickness. The results of his researches were published in the Reports of the Sleeping Sickness Commission of the Royal Society (1912, 1913 and 1919) and were presented as a dissertation for his D.M. degree at Oxford.

In the First World War, Hale Carpenter served as a captain in the Uganda Medical Service, his duties taking him into many interesting parts of Africa that he would otherwise never have visited and providing him with rich material for his book "A Naturalist in East Africa" (1925) and for many scientific papers on insect bionomics, polymorphism and mimicry. For his war services he received the M.B.E. On demobilization he resumed his work on tsetse fly, becoming specialist officer for the control of sleeping sickness in Uganda. He retired from the Colonial Medical Service in 1930; but at the request of the Secretary of State for the Colonies undertook a special investigation into tsetse fly in Ngamiland during 1930–31.

While in Africa, Hale Carpenter kept up a voluminous correspondence about his observations on insects with Sir Edward Poulton, Hope professor at Oxford, and on returning to England he built a house on Cumnor Hill, just outside that city. For a year or two he visited the Hope Department of Entomology, Oxford University Museum, daily, studying the vast stores of African insects, many of which he had collected himself, and helping Sir Edward Poulton. When Sir Edward retired in 1933, Hale Carpenter succeeded him, occupying the chair for the next fifteen years, and so qualifying for the title of emeritus professor on his retirement in 1948. During this period he continued his studies on mimicry and geographical distribution, and paid special attention to the vexed question of the attacks of birds on butterflies and its significance for evolutionary theory. At the same time he was deeply concerned about the future of his Department, and not only did all he could to enhance its value, but also appealed to the University for a new building and an increased staff.

During the Second World War, Hale Carpenter lectured on camouflage and tropical medicine to troops in training near Oxford, prepared special booklets for the African campaigns and served as head warden of the air-raid precaution service for Cumnor.

He frequently attended and spoke at scientific meetings in London, was president of the Royal Entomological Society during 1945–46, vice-president of the Linnean Society during 1935–36 and was an ardent supporter of the British Association.

His writings included "A Naturalist on Lake Victoria" (1920) and "Mimicry" (1933). His study of the genus *Euplœa*, a genus of butterflies found on many Pacific Islands, was completed shortly before his death and is to appear in the *Transactions of the Zoological Society of London*.

Hale Carpenter was a tall, distinguished-looking man with white hair, easy of address and with a keen sense of humour. His chief recreation was gardening, the varied soils at his home at Cumnor Hill enabling him to grow a wide variety of plants. He was an ardent churchman, secretary of the Parochial Church Council, and chairman of the Cumnor branch of the Oxford Preservation Trust. His holidays were often spent in Cornwall, where he would walk, watch birds and collect insects.

He married in 1919 Amy Frances Thomas-Peter, of Treviles, Cornwall, who survives him.

B. M. Hobby

Prof. N. A. V. Piercy

In the passing of Prof. N. A. V. Piercy, on February 1, the profession of aeronautical engineering has lost one of its ablest teachers and a pioneer in the teaching of aeronautics.

Norman Augustus Victor Piercy was born in London on August 10, 1891, and after being educated at Hampton Grammar School he was apprenticed to Yarrow and Company, Scotstoun (1908–13). He obtained an honours degree (London) in engineering at East London College (now Queen Mary College) in 1913 and immediately became engaged at Shoreham on the Cedric Lee aeroplane, known as the 'Doughnut', which had a circular ring for its wing plan-form. The period until 1919 found him engaged at East London College in researches on this novel wing, as well as special investigations for the Admiralty. During this time he designed his own 4-ft. wind tunnel, which was built of steel plating obtained from a destroyer. This tunnel is still in use.

In 1919 he was appointed head of the Department of Aeronautics at East London College and started the first university course with aeronautics as a recognized subject. In 1920 he obtained his D.Sc., for his work in connexion with the flow behind aerofoils. His subsequent researches in aerodynamics included flow in pipes, heat flow from moving bodies and aerofoil theory from which the 'Piercy aerfoil' was developed.

As a teacher Piercy inspired his students, and in consequence he soon gathered a small team of research workers around him. In 1934 he was appointed reader in aeronautics in the University of London, and in 1949 his work was officially recognized when the title of University professor of aeronautical engineering at Queen Mary College was conferred upon him.

During the Second World War Piercy was in charge of the Aeronautical Department in the University of Cambridge, in addition to his work at Queen Mary College.

Piercy was the author of "Aerodynamics", which was published in 1937 and revised in 1947, "Elementary Aerodynamics", published in 1944, as well as various papers read before learned societies. At the time of his death he was engaged in a third edition of "Aerodynamics", incorporating more recent advances in supersonic flow. He was a man of amazing energy

and served on many committees dealing with the teaching of aeronautics, as well as being a member of the Council of the Royal Aeronautical Society during 1935–39. His other interests included music—he was an able pianist—golf and the collecting of antiques.

H. F. Winny

Dr. Y. A. Bilibin

Yury Alexandrovich Bilibin was born on May 19, 1901, in Rostov in Yaroslav province, and he died on May 4, 1952, in Moscow. After active participation in the civil war of 1917–21, he graduated in 1926 at the Leningrad Mining Institute. His scientific work is intimately associated with the geological survey of Eastern Siberia, and he became an authority on the mode of occurrence and mode of origin of ores of gold, tin, copper and other metals. He constructed metallogenetic maps and lectured on metallogenetic provinces, and made considerable progress in the application of geochemistry to the problem of ore genesis. He also published important papers on the igneous rocks of the Aldan region in Eastern Siberia and was particularly interested in the origin of alkaline rocks. In 1943 he received his doctorate and was later elected a corresponding member of the Academy of Sciences. In 1948 he came to London to take part in the meeting of the International Geological Congress, and those who met him there will remember him as a shy but very friendly person who was an outstanding geochemist and geologist.

S. I. Tomkeieff

We regret to announce the following deaths:

Mr. Andrew Gray, technical general manager during 1928–32 of Marconi's Wireless Telegraph Co., Ltd., and an early assistant of Marconi, aged eighty.

Prof. J. W. McBain, F.R.S., emeritus professor of chemistry in Stanford University, California, and lately director of the National Chemical Laboratory, India, on March 12, aged seventy.

NEWS and VIEWS

Agriculture in the University of Sydney: Prof. W. L. Waterhouse

Prof. W. L. Waterhouse, research professor in the Faculty of Agriculture, University of Sydney, retired at the end of 1952. During his thirty-two years of service, he had occupied the positions of lecturer, reader and professor. Prof. Waterhouse lectured on plant pathology, genetics and plant breeding, and agricultural botany. The scientific discipline derived from these courses was ideal, and has stood many graduates in good stead no matter in what field of scientific endeavour they work; his teaching was inspired. His main researches were in the field of cereal diseases, in which he accepted the challenge of solving the wheat rust problem of Australia. He had many successes, the culmination of his work from a practical point of view resulting in the production of an outstanding variety known as Gabo, which was resistant to all the forms of stem rust existent in Australia up to 1948. But perhaps his greatest contribution was to give a complete understanding of the problem, a thorough knowledge of the rusts, techniques for breeding resistant varieties, and above all hope for the future. Prof. Waterhouse has been a good colleague and has played a considerable part in developing the Faculty of Agriculture in the University of Sydney. Although handicapped by wounds sustained in the First World War when he was awarded the Military Cross, he never spared himself in his teaching and research. Prof. Waterhouse's work has been recognized by many awards: he was given the Farrer Memorial Medal in 1937 and again in 1950; in 1943 he received the Clarke Memorial Medal of the Royal Society of New South Wales, and in 1948 the Australian Medal of Agricultural Science. Now his University has conferred on him the title of emeritus professor. Truly can it be said that here is a man who has devoted himself to science and to agriculture, so that the lot of the farmer and the community might be improved and the world made a better place in which to live.

Geophysics at the Carnegie Institution of Washington: Dr. P. H. Abelson

Dr. Philip H. Abelson, chairman of the Biophysics Section of the Department of Terrestrial Magnetism in the Carnegie Institution of Washington, has been appointed director of the Geophysical Laboratory of the Institution with effect from September 1 next. Dr. Abelson's research career began under Prof. Ernest O. Lawrence at the University of California, Berkeley, where he made the initial identification of radioactive antimony, tellurium and iodine as products of uranium fission, gaining his Ph.D. in 1939. He then joined the Carnegie Institution as a staff member and took a prominent part in the design and construction of the cyclotron at its Department of Terrestrial Magnetism at Washington, D.C. During the Second World War he was a physicist at the Naval Research Laboratory, where he developed the liquid thermal diffusion method for enrichment of uranium-235, and under his general supervision a plant employing the method was designed and constructed at Oak Ridge for work in connexion with the atomic bomb. Dr. Abelson returned in 1946 to his old Department in the Carnegie Institution and organized a programme of biophysical work for using isotopes and radioactive nuclei in the study of the processes by which living cells select chemicals from their environment and organize them into new cells; as a result, a number of processes in the chemistry of amino-acids have been elucidated. At the same time he has continued his interest in geophysics and geochemistry, and in his new post he is going to a laboratory where during recent years much of the work has been focused on novel experimental techniques for studying the physics and chemistry of the solid state, such as the melting and solubility relations of silicates, especially in the presence of water, and the transport of minerals by solution in a gas phase.

Dannie Heineman Prize of the Heineman Foundation

The first award of the Dannie Heineman Prize of the Heineman Foundation for Research, Educational,

Charitable and Scientific Purposes, Inc., has been made to Prof. Otto Neugebauer, of Brown University, Rhode Island, for his book entitled "The Exact Sciences in Antiquity" (Princeton University Press, 1951, and Oxford University Press). The Prize, which is worth five thousand dollars, will be awarded every three years to the author of an outstanding book on mathematical or physical sciences which opens up important fields of research. Prof. Neugebauer, who is an Austrian by birth, is a mathematician who has turned his knowledge to the study of Egyptology and, in particular, to the deciphering of Babylonian and Sumerian cuneiform texts dealing with mathematical and astronomical subjects. The Heineman Foundation was established by Mr. and Mrs. Dannie N. Heineman, of Charlotte, North Carolina, in order to further educational, charitable, religious and scientific enterprises and projects, without reference to nationality, race, creed or colour. Further information can be obtained from the secretary of the Foundation at Suite 1700, 50 Broadway, New York 4, N.Y.

Oil Palm Research in Nigeria

THE Oil Palm Research Station, Benin, formerly a station of the Nigerian Agricultural Department, has recently been transformed into the West African Institute for Oil Palm Research. This Institute has been set up by statute to serve the British West African territories in all matters relating to research on the oil palm—a tropical crop of great contemporary value and importance. Annual reports on the work of the Institute are promised in due course, these continuing the records of the former Research Station. Meanwhile, quarterly progress reports are being made available to those who are interested in this crop; for the managing committee is anxious to make the work of the Institute as widely known as possible. Leaving aside the numerous matters of administrative detail, inseparable from the establishment of a new organization, the contemporary report (No. 3; October–December 1952) contains items of scientific and practical interest on problems of seed germination, the effect of leaf pruning, the effect of burning and non-burning techniques of land-clearing on subsequent yields—a matter of rather special interest to the tropical planter, the agronomist and the soil chemist—genetical and breeding investigations and progeny trials, and the investigation of various obscure diseases to which the oil palm is subject. Although at several points the work has been restricted and impeded by staffing difficulties, the Institute is now an active going concern. For this, much credit is due to the director, Mr. F. W. Toovey, for a notable administrative and scientific achievement in the face of difficulties that only workers with tropical experience are likely to appreciate to the full.

Association of Clinical Biochemists

THE Association of Clinical Biochemists was formed at a meeting held at the Postgraduate Medical School of London on March 28. Regional societies in the Midlands, Glasgow, the north-west and the south of England have been in existence for some time, and an interim committee of these groups was set up last year under the chairmanship of Prof. E. J. King. The activities of the new Association will be both scientific and professional and will comprise the field, now somewhat incompletely covered, between pathology, clinical medicine and biochemistry. The Association will hold regional and national meetings for reading papers and giving demonstrations, and expects to hold joint discussions with other organizations to deal with selected topics. It hopes to co-operate with other societies affiliated to the International Association of Clinical Biochemists in a scheme for the standardizing and periodical checking of analytical methods used in hospital laboratories. The following papers were read at the inaugural meeting: Mr. E. B. Love, on the laboratory control of anticoagulant therapy; Dr. I. D. P. Wootton, on the quartz spectrophotometer in clinical chemistry; Drs. H. Bickel, J. Gerrard and E. M. Hickmans, on the influence of phenylalanine intake on phenylpyruvic oligophrenia; and Dr. A. L. Latner, on quantitative paper-strip electrophoresis of serum proteins. The meeting accepted a set of rules submitted by the interim committee, which was instructed to nominate a president and to hold elections to a council not later than August 31. Until then the interim committee is to act as a temporary council; Dr. A. L. Tárnoky (Royal Berkshire Hospital, Reading) is secretary of the committee.

Deep-sea Trawling

THE results of the deep-sea trawling which was done by the Swedish Deep-Sea Expedition, 1947–48, are given in the "Reports" of the Expedition (2, Fasc. 1; 1951. Pp. 148+2 plates. Göteborg: Elanders Boktryckeri. 25 kr.). In an introductory paper, Dr. O. Nybelin, who was in charge of the zoological work, discusses the technical difficulties of trawling at depths greater than four thousand metres. For this work the expedition employed a thirty-foot otter trawl, of the type used by Scandinavian fishermen to catch the deep-water prawn, *Pandalus borealis*. In the operation of this trawl, considerable use was made of echo-sounding to avoid trawling over hard, rough bottoms, and also of calculations (by B. Kullenberg) on the shape and length of the cable during deep-sea trawling. Dr. Kullenberg's calculations are also published in the present volume. As a result of this preliminary attention to details of technique, the Swedish deep-sea trawl-hauls were relatively more successful than many of those taken on previous expeditions, and the remaining papers in the publication record the zoological catches, in particular the echinoderms, cœlenterates, bryozoans and polychætes. The starfish collections, described by Jensenius Madsen, strongly support the view that the real deep-sea fauna is essentially cosmopolitan. Thus, three species of starfish found by this expedition in the Atlantic had hitherto been known only from the Pacific or Indian Oceans.

Mathematical Association: Meeting in Sheffield

THE annual general meeting of the Mathematical Association will be held in the University of Sheffield during April 8–11. The business of the Association (election of officers and the Council, etc.) will be dealt with on the morning of April 9, and in the afternoon the president, Mr. K. S. Snell, of Harrow School, will give his address, his subject being "School Mathematics To-day and To-morrow". Other topics which will be considered at the meeting are the craft and science of metallurgy, infinity, the Mathematics Division of the National Physical Laboratory, the transition from the primary to the secondary school, the theory of games, and 'from examination question to industrial problem'. In

addition to the usual exhibition of books, it is hoped to arrange an exhibition on teaching-aids in primary and secondary schools and another one on modern calculating machines. All arrangements for the meeting are in the hands of the local secretary, C. R. Barwell, 53 Duke's Drive, Newbold, Chesterfield, from whom further information can be obtained.

Scientific Film Association

At the annual general meeting of the Scientific Film Association, the following officers were elected for the year 1953–54: *President*, Sir Arthur Elton; *Vice-President*, W. J. C. Chapple; and *Honorary Treasurer*, K. Baron Hartley. As a result of recent changes in the articles of association, the council of management will in future consist of the officers, six elected members and seven members nominated by the Lord President of the Council to represent general scientific and public opinion. The elected members are B. Chibnall, Dr. R. C. MacKeith, J. Maddison, C. A. Ronan, C. H. Sylvester and R. A. Williams; the members nominated by the Lord President are Mrs. Jacquetta Hawkes, Dr. F. H. K. Green (Medical Research Council), Dr. Alexander King (Department of Scientific and Industrial Research), Sir Ian Orr-Ewing, J. Ryan, Sir William Slater (Agricultural Research Council) and Sir Robert Watson-Watt. The address of the Association is 164 Shaftesbury Avenue, London, W.C.2.

Direct Reading Emission Spectroscopy

The Industrial Spectroscopy Group of the Institute of Physics has formed a panel of members interested in direct-reading equipment for spectrochemical analysis. These devices combine spectrographs with electronic equipment in such a way that the intensities of characteristic spectral lines give a direct reading of the percentage of the elements present in the specimen. The object of the panel is to organize meetings which would serve the interests of users and potential users of this equipment. The first meeting arranged by the panel took place in the Institute's House on March 26 last, when Dr. A. C. Menzies introduced the subject. Mr. A. L. Pendrey and Mr. R. T. Staples gave accounts of their experiences in this type of work, and there followed a general discussion. Particulars relating to meetings on this subject can be obtained from the Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

Handbook of Scientific Instruments and Apparatus

The annual "Handbook of Scientific Instruments and Apparatus", giving details of the exhibits at the Physical Society's annual exhibition, is now a publication familiar to all men of science and manufacturers of scientific instruments. This year's exhibition, the thirty-seventh of the series, is to be held at the Imperial College of Science and Technology, South Kensington, London, during Monday, April 13–Friday, April 17, and will be opened on April 13 at 10.30 a.m. by Prof. R. Whiddington, president of the Physical Society. Three discourses are being given this year: (1) Dr. E. C. Bullard (director of the National Physical Laboratory) on "Seismic Study of the Ocean Basins"; (2) Dr. L. A. Jordan (director of the Paint Research Station) on "Particles, Pellicles; Pigments, Paints and Physics"; and (3) Prof. W. V. Mayneord (Department of Physics, Royal Cancer Hospital) on "Scintillation Counting and its Medical Applications". The prize distribution of the Craftsmanship and Draughtsmanship Competition will take place during the exhibition on April 13 at 5 p.m. The handbook, a volume essential to all workers interested in the progress and development of scientific instruments, gives instructive descriptions of the many instruments shown by about a hundred and fifty exhibitors, including government research establishments. This extremely useful volume, which is now available, is printed on glossy paper and is illustrated by numerous half-tone reproductions of scientific instruments. It should be in the hands of all physicists and scientific workers who use or design scientific instruments (pp. xii+262+A72. Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7. 6*s*., or 7*s*. 3*d*. post paid).

Announcements

Sir Henry Beresford-Peirse, director of forestry for Scotland since 1947, has been appointed deputy director-general of the Forestry Commission. He will be succeeded in Scotland by Mr. A. H. H. Ross, at present conservator of forests for north-west England.

The following have been appointed lecturers in the Queen's University of Belfast: S. McConaghy (agricultural chemistry), R. E. Parker and Dr. E. W. Simon (botany), and Dr. I. Leslie (biochemistry).

The Commonwealth Fund (35 Portman Square, London, W.1) has awarded the following Home Civil Service Fellowships to British Civil servants for study in the United States during 1953–54: B. R. Feaver (Forestry Commission (Scotland)), G. Leitch (Ministry of Supply), L. S. Mills (Ministry of Civil Aviation) and P. E. Watts (Ministry of Fuel and Power).

The Bone and Tooth Society will hold a symposium on "Vitamin C and Bone" on April 9 at the Institute of Orthopædics, 234 Great Portland Street, London, W.1. Dr. E. H. Allen will speak on "X-Ray Findings in Scurvy"; Dr. L. E. Glynn on "Vitamin C and Ground Substance"; Dr. G. H. Bourne on "Vitamin C and Ossification"; and lastly Dr. B. E. Clayton on "Cortisone and Vitamin C".

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the academic year beginning October 1, 1953, or earlier, a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics, and agricultural and dairy engineering. The closing date for applications is May 1. Further particulars can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1–4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

A Science Meeting of the Physical Society will be held at the Imperial College of Science and Technology, London, S.W.7, during May 15–16, the subject of which will be "Recent Research in Electron Optics". The meeting is being arranged by Dr. O. Klemperer, of the Imperial College, and will be divided into seven sections as follows: electron lenses; correction of aberrations; electron guns; focusing in electron accelerators; electron optics in television tubes and valves; electron spectrometry; other subjects. Visitors wishing to attend this meeting should apply to the offices of the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, for further particulars; the closing date for applications is May 7.

SHEEP BIOLOGY LABORATORY, PROSPECT, NEW SOUTH WALES

By Prof. C. W. EMMENS

Department of Veterinary Physiology, University of Sydney, and Officer-in-charge of the Prospect Laboratory

THE Wool Use Promotion Act 1945 and the Wool Industry Fund Act of 1946, of the Commonwealth Government of Australia, made provision for additional funds to be devoted to the expansion of sheep and wool research. As a result of a survey made by the Commonwealth Scientific and Industrial Research Organization, it was clear that, although considerable progress had been made in the control of the diseases of sheep, relatively little had been achieved in the improvement of the productivity, including fertility, of the healthy animal.

It was therefore decided to found, within the Division of Animal Health and Production, a Sheep Biology Laboratory where problems of this sort would be tackled. A site of 116 acres was selected at Prospect, New South Wales, about twenty miles from Sydney, and acquired in September 1946. Plans were made to start work and to extend existing programmes without waiting for certain of the facilities at Prospect. Units eventually to move into the Sheep Biology Laboratories were strengthened, and new ones were set up in various other centres in Victoria and New South Wales. These have grown to such an extent that the staff destined for Prospect already amounts to some seventy or eighty persons.

The most important buildings, some of which are yet to be constructed, are as follows.

Animal houses. These are primarily intended to house sheep in single pens, or small multiple pens, and, so far, one has been constructed. Each is 282 ft. long by 40 ft. wide and accommodates about a hundred and fifty animals. At each end of these houses are offices, record rooms and various other servicing units.

Fleece and shearing building. This is 150 ft. by 40 ft. and is to be used for handling fleeces from shearing to storage, with air-conditioned laboratories attached for the study of fleece samples under standard conditions. It is ready for use.

Climate control and examination building. This will be a two-story building, 182 ft. long by 45 ft. wide, containing two climate-control rooms, each 13 ft. by 24 ft., and a larger preconditioning room of 24 ft. by 37 ft., small animal colonies, a clinical wing with operating theatre and associated rooms, and an X-ray unit as well as a photographic studio. In the climate-control rooms any prescribed climatic conditions will be maintained, and the rest of the building will have appropriate air conditioning.

Prefabricated buildings. These comprise two aluminium buildings, each 153 ft. by 40 ft., to be used as laboratories, stores, canteen, etc., while the main laboratory is under construction. They are nearly ready for occupation, and will house the first groups of workers mentioned above. When the Main Laboratory is ready, most of the workers will move into it; but some may remain in the prefabricated buildings.

Main laboratory building. This will be of two stories, approximately 215 ft. by 42 ft., with a single-story library wing. It will house the main group of laboratories, offices, library, records and storage rooms. Both this and the prefabricated buildings will be air-conditioned.

Other buildings, covering with those already specified an area of about five acres, are a large garage and workshop, a feed store, and various smaller sheds and houses for miscellaneous equipment. The main buildings will eventually be connected by covered ways giving sheltered access to almost any of the central group of facilities.

The following existing Research Sections will be housed in the Prospect Laboratories as soon as possible.

Wool Biology. This is a Section with an essentially long-range programme of work, directed in the first instance to the study of the skin and the fleece of sheep, but on a comparative basis. At present, the work of the Section falls under six main headings: the comparative development of the skin in sheep and other mammals, with special reference to the hair follicle group and its associated glands; the physiological mechanisms associated with skin, particularly with the growth of wool and the activity of the sebaceous and sweat glands; genetic effects on the growth and development of skin and their interactions with the above; the efficiency of fleece production in different breeds and strains; aspects of the physiology and anatomy of heat regulation in different breeds and strains; the relationship between fleece types and such environmental factors as nutrition, temperature and illumination.

Fleece Analysis. This is a Section responsible for the study and development of methods of measuring fleece characteristics, such as fibre length, fibre diameter, fleece density, and the variability associated with them. This Section already makes many thousands of examinations a year in association with the experimental programmes, mainly field studies, of other Sections or outside organizations, while simultaneously developing its own research programme. Physicists from this Section will also be responsible for the running of the climate-control rooms.

Reproductive Physiology. Two small groups of research officers and one or two isolated research workers form the nucleus of the Prospect team. At present they are working on the following lines: problems connected with the occurrence and distribution of matings in flocks under different conditions, and of subsequent pregnancies; the capacitation phenomenon in spermatozoa; problems connected with reproduction in the domestic fowl; and the preservation of semen under refrigeration. Most of these workers have also been concerned with investigations in the infertility of sheep on subterranean clover pastures, in collaboration with university research teams, a project which has resulted in the isolation of genistein, an œstrogenic *iso*-flavone, from the affected pasture.

Ruminant Digestion and Physiology. In this Section the sheep is taken as the main experimental subject; work is already in progress on the digestion of protein and on the metabolism of carbohydrate and fat. It is planned to expand these researches and to build up a team of investigators whose broad terms of reference will be physiological problems especially related to the ruminant.

Field Studies. The new laboratory will act as a centre, not only for laboratory research, but also for the organization of field trials, observations of stud and other practices, and for the collection of information from all possible sources. Officers of the present Wool Biology Section are now active in this field; in addition, they and others are collaborating in projects known as the 'strain trials', in which the performance of five different strains of merino sheep is being studied at three different localities in the eastern half of Australia. The trial will continue for many years. Such field studies as these are often best interpreted in the light of concurrent work on the smaller, closely controlled groups of animals for which the facilities of the Sheep Biology Laboratory were designed.

Following the lead of institutions like Rothamsted Experimental Station in Britain, the Sheep Biology Laboratory will develop a strong statistical section. Other aspects of its present structure that will be strengthened are the more biochemical and biophysical parts of the work. The exact degree to which it may participate in work of a more-or-less purely genetic nature will depend on its relationship with the newly formed Section of Animal Genetics of the Commonwealth Scientific and Industrial Research Organization, part of which may also be located at Prospect.

BRITISH COMMONWEALTH GEOLOGICAL LIAISON OFFICE

DURING the recent nineteenth International Geological Congress at Algiers, the first meeting of the British Commonwealth Committee on Mineral Resources and Geology was held in the British Consulate Office, at which the following representatives of their respective Geological Surveys attended: Mr. C. J. Sullivan (Australia), Dr. J. W. Harrison (Canada), Dr. F. Dixey (the Colonies), Dr. B. C. Roy (India), Dr. N. M. Khan (Pakistan), Dr. A. M. MacGregor (Southern Rhodesia), Dr. L. T. Nel (South Africa), Dr. W. J. Pugh (United Kingdom) and Mr. R. W. Willett (British Commonwealth geological liaison officer).

The British Commonwealth Geological Liaison Office and the British Commonwealth Committee on Mineral Resources and Geology were set up on the recommendation of the 1948 Specialist Conference on Mineral Resources and Geology, the purpose and scope of the office being defined in the report of that Conference (Code No. 47–149. London: H.M.S.O., 1949). As a result, the Geological Liaison Office was established in May 1951 at the British Commonwealth Scientific Offices, Africa House, London, and at the same time the present British Commonwealth geological liaison officer, R. W. Willett, of the New Zealand Geological Survey, commenced duties.

The recommendations of the 1948 conference were as follows. (*a*) Permanent Commonwealth machinery should be set up to promote collaboration and interchange of information between government organizations concerned with the investigation of geology and mineral resources throughout the British Commonwealth. This machinery should take the form of a Committee, to be known as the Committee on Mineral Resources and Geology, with members representative of such organizations from each of the participating countries meeting at intervals of not more than three years in a Commonwealth country. (*b*) The permanent executive and secretarial work of this Committee should be under the direction of a senior officer with appropriate technical qualifications stationed in London, who would be known as the British Commonwealth geological liaison officer. His duties would include: acting as a liaison officer in matters pertaining to geology and mineral resources for all participating members of the British Commonwealth; taking appropriate action to give effect to the recommendations of the present Conference; and making the preliminary arrangements for the periodical meetings of the Committee.

Dr. W. J. Pugh, director of the Geological Survey of Great Britain, was elected chairman and will now hold office until the Committee meets again, which will be when a suitable and appropriate occasion offers. The Committee reviewed and discussed the annual report of the Geological Liaison Officer, and the progress made in translating into action the original recommendations, and endorsed the action taken; as a result, it recommended the continuance of the Geological Liaison Office along the lines already laid down. The geological liaison officer is appointed for three years, at the end of which period he is replaced by another Commonwealth officer selected and appointed in the same manner. The first annual report of the Office was presented at a recent meeting of the Committee, and in it the scope and extent of the work of the Office were outlined.

As a background to the work of the Office, a series of reports are being prepared on the mineral resources of the British Commonwealth. These reports present the essential quantitative and qualitative information on the various mineral deposits in the Commonwealth and are based on the latest published information and on unpublished information, obtained by correspondence where necessary, with various Commonwealth Surveys. So far, nineteen metals and non-metals have been covered in this manner—namely, copper, lead, zinc, cobalt, nickel, antimony, manganese, tungsten, vanadium, molybdenum, chromium, beryllium, zirconium, titanium, niobium and tantalum, phosphates, sulphur and asbestos. These are circulated to the United Kingdom Ministries concerned, to members of the Commonwealth Committee on Mineral Resources and Geology, the Defence Advisory Committee on Commonwealth Mineral Resources and to the Commonwealth scientific liaison officers at Africa House, London. It is hoped to cover the entire field of industrial minerals and rocks and, with certain modifications, to publish these reports in the form of a single volume.

Some preliminary action is being taken on the subject of the presentations of mineral statistics, in order to explore the possibility of greater uniformity in the use of units and methods of presentation. The recommendation of the 1948 Specialist Conference asking all Commonwealth countries to prepare and issue an annual volume of abstracts of geological papers of the territories under their control has not yet been put into action by all the countries concerned. In order to assist in this work, the Geological Liaison Office has prepared such a volume of United Kingdom abstracts for 1951 for limited distribution, which will be followed by that for 1952. If this experiment is successful, an attempt will be made to extend this work to those countries of the British

Commonwealth which are not already preparing their own annual volumes of abstracts.

The geological liaison officer serves on a number of committees concerned with mineral resources, their development and utilization. The officer, as a specialist on the subject of geology and mineral resources, also acts in close liaison with the scientific liaison officers of the other Commonwealth countries, and at the same time close liaison is maintained with the Ministry of Materials, Department of Scientific and Industrial Research and other Ministries in Great Britain which are interested in the mineral resources and their availability throughout the Commonwealth. Reports and accounts of meetings and conferences concerned with geology and mineral resources are also prepared and circulated to the Commonwealth countries.

Close contact is maintained by the Geological Liaison Office with the Colonial Geological Surveys Directorate, as the two organizations are in a sense complementary; the latter links all the Colonial Geological Surveys, while the former is an attempt to link, in a less formal way, the Commonwealth Geological Surveys. The Geological Liaison Office is now charged, as a result of recommendations by the British Scientific Official Conference in Australia, with the formation of Commonwealth collaboration on geophysical prospecting, and the beneficiation and utilization of low-grade ores. The Office is now firmly established as an intrinsic part of the British Commonwealth Scientific Office, and, as an experiment in a purely Commonwealth organization, appears to be functioning with some measure of success.

RECORDING OF RESEARCH AND ITS PATENT ASPECTS

MANY research workers, more usually the younger ones, dislike keeping adequate records of their investigations, but the fact has to be faced that the keeping of proper records is probably much more important, and a much less simple obvious matter, than is often supposed. Various aspects of the subject were discussed last year by a joint committee of the Franklin Institute and of the American Patent Law Association in a programme entitled "Who is the First Inventor ?"; and further consideration has been given in a recent timely and interesting article by J. G. Jackson, on "Records of Research" (*J. Franklin Inst.*, 254, 355; 1952).

There are, of course, several sound reasons for keeping good records, many of which are sufficiently obvious without undue elaboration. (*a*) Avoidance of duplication, especially in prolonged research, when problems may again crop up that have been already studied and not recorded. (*b*) Taking full advantage of negative results, which also may prevent duplication if properly noted at the time. (*c*) Assisting the development of a fundamental approach, for very often at the start the workers are somewhat in the dark, or are taking part in one small section of a comprehensive programme, so that they think their results are relatively unimportant and not worth reporting; but such data later on prove essential in developing a theory or fundamental approach. (*d*) Publication; when work is published or reported at a meeting, supplementary questions arise which cannot be answered because full data have not been recorded. (*e*) Patent requirements; for example, insufficient record prevents the inventor from establishing that he was the first inventor, and it may thus happen that the company which developed the subject-matter may be forced to take a licence under someone else's patent.

The very minimum of information that should be recorded is the date of commencement of work, by whom it is done, detailed account of the work (with date of each important step) and the results. Such recording may often be the proper function of the research director or group supervisor. For patent purposes it is absolutely essential that provision be made for corroboration, and this is discussed at some length by Mr. Jackson. Some useful practical notes on this part of the subject can be found elsewhere[1,2].

Certain milestones in connexion with research in industry should be formalized, to enable firms to determine the progress being made and the status at each stage. These formal steps are very helpful in tying together various records for patent purposes; and assigning project numbers is, for the same reason, of great assistance.

Several valuable suggestions on the keeping of laboratory notebooks are given: step-by-step records in order of time; making of sketches and drawings; issuing a specification on an item under development before it is standardized (which constitutes a valuable record of research); photographs and samples; and codes and abbreviations. These last-named may often be the cause of much trouble and confusion, some curious examples of which are given. Special records may sometimes be required from the point of view of patents, on which much useful advice is provided. Finally, it is pointed out that publications perform certain functions as research records, and have a special significance in patent matters.

[1] Kapp, "Laboratory Notebooks", 33 JPOS (*J. Pat. Off. Soc.*, 502 (1951).

[2] Tuska, "Patent Notes for Engineers", 3rd edit. (Radio Corp. America, 1947).

ELECTRONIC DIGITAL COMPUTERS

CONFERENCE IN THE UNITED STATES

IN 1950 a meeting was held in Atlantic City, N.J., to discuss electron tubes for computers. The meeting was initiated by Dr. A. L. Samuel, as representative of the Research Development Board, and was sponsored by the American Institute of Electrical Engineers and the Institute of Radio Engineers. The success of this initial meeting led Prof. J. G. Brainerd to suggest the formation of a joint computer conference committee between these two last-named bodies in order to consider whether further meetings should be held and, if so, on what subjects. It was decided that the subjects which required urgent attention were electronic digital computers, input and output equipment, high-speed memory and choice of number system. Accordingly, the joint conference held in Philadelphia, Penn., during December 10–12, 1951, dealt with the first topic, and a recent conference, during December 10–12, 1952, at New York City, was concerned with input and output equipment.

The 1951 meeting, at which the Association for Computing Machinery also co-operated, attracted an attendance of 877 members, and the eighteen papers

and discussions that were presented have recently been published*. Ten different large-scale electronic computers of varying design and performance are separately described. These are the UNIVAC, ORDVAC, EDSAC, SEAC, ERA 1101, Burroughs Laboratory, Whirlwind I and the University of Manchester computers, and the IBM card-programmed and the Mark III electronic calculators. In other papers detailed operating and component experience on certain of these instruments is discussed. In addition, a report on the use of computing machines in aircraft engineering is given by C. R. Strong, of the Douglas Aircraft Co., the seven digital computers designed and built by the Bell Telephone Co. are described by E. G. Andrews, and the application of transistors to digital computation is discussed by J. H. Felker.

Finally, a summary of the present status and future trends of digital computers is given by J. W. Forrester, in which he states that it is clear that the pioneering days are over and that enough experience of the various models has now been gained to judge the adequacy of the designs. Though there are quite definite lines of development—for example, towards machines of still higher speed—it is worth while to note the concluding sentences of Mr. Forrester's summary which aptly summed up the position at the end of 1951: "Machine speed has increased by several orders of magnitude over the last ten years. In the future we can perhaps get another decade in speed, but I doubt that more can be accomplished without a fundamentally new type of computer. The great steps in the near future will be in the direction of simplification without losing performance. It seems clear that the complexity of computers can and must be reduced."

* Review of Electronic Digital Computers: Joint AIEE–IRE Computer Conference. Papers and Discussions presented at the Joint AIEE–IRE Computer Conference, Philadelphia, December 10–12, 1951. Pp. 114. (Amer. Inst. Elec. Eng., 33 West 39th Street, New York 18, 1952.) 3.50 dollars.

PRODUCTION OF HIGH VACUA BY IONIZATION

A LITTLE while ago, Dr. A. von Engel directed attention to the method of obtaining high vacua by ionization (*Vacuum*, **1**, No. 4; Oct. 1951); it is therefore of interest to note that a discussion of the principles and limitations of such pumping action, together with a description of an electronic pump which was the subject of a German patent in 1943, is given in a paper by H. Schwarz*.

The idea of obtaining high vacua by ionization is, of course, quite old and well known, and the clean-up, that is, absorption of gases or vapours, in an electrical discharge is a common experience and fairly well understood. Dr. Schwarz, however, shows theoretically that it is not possible, even under the most favourable conditions, to construct a high-vacuum pump with reasonable dimensions utilizing a normal D.C. gas discharge. A real pumping action can only result when there is such a high ion-current that the number of ionized gas molecules transported in one direction is greater than the number of gas molecules diffusing back in the opposite direction. It is necessary, therefore, to increase the path of the electrons without increasing the length of the tube, and this may be accomplished either by making the electrons oscillate on screw paths about the tube axis, or by using an external magnetic field which forces the electrons to travel in spiral paths within a cylindrical electrode system, as in the magnetron or cyclotron.

The model of an electronic pump which Dr. Schwarz describes consists of an incandescent cathode, a ring-shaped anode at about 2,000 V. and a third annular electrode at cathode potential. The 10-mA. electron current is kept oscillating through the anode, and a magnetic field parallel to the tube axis keeps the electrons on spiral paths at the centre of the tube away from the anode. Special arrangements are made to remove absorbed gas from the glass walls of the tube and to prevent ions from diffusing back into the high-vacuum side. As a test of the pump, a volume of half a litre was pumped down from a pressure of 10^{-3} to 10^{-5} mm. of mercury in less than one second.

* Centro Brasileiro de Pesquisas Fisicas. Notas de Fisica No. 5: Methods of obtaining High Vacuum by Ionization; Construction of an 'Electronic Pump'. By Helmut Schwarz. Pp. 9. (Rio de Janeiro: Centro Brasileiro de Pesquisas Fisicas, 1952.)

CULTIVATION OF SULPHATE-REDUCING BACTERIA

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STUDIES on the bacteriology and biochemistry of the sulphate-reducing bacteria have long been obscured by inconsistencies in the behaviour of these organisms. For example, tests on the ability of a single strain to utilize various sources of carbon may give different results on different occasions; subcultures sometimes fail to grow, or grow with a very long lag, for no obvious reason; dilution counts on a motile and obviously healthy population indicate that rarely more than 10 per cent and often as little as 0·01 per cent of these cells are apparently viable; strains grown with excess of ferrous ions in the medium often do not grow readily without this; and so on. Though the capriciousness of these bacteria has not often been described explicitly in the literature, it is common experience among workers in the field. The observations described below to some extent clarify the situation. Since they bear closely on the work of other laboratories studying these bacteria, and since they have required a re-assessment of earlier work in this laboratory, we have felt that this preliminary report is desirable.

The fundamental observation, that reducing agents stimulate the activities of these bacteria, has been reported by many sources, including this laboratory[1–4], and the importance of a negative redox potential for their effect in anaerobic corrosion was emphasized by Starkey and Wight[5].

Methods. Strains of *Desulphovibrio desulphuricans* were cultured at 30° C. in anaerobic jars containing hydrogen plus 5 per cent carbon dioxide or in sealed test-tubes containing a plug soaked in pyrogallol with strong sodium carbonate. For normal subcultures a 1/100 dilution of a grown culture was made into fresh medium. Dilution counts were performed in duplicate by making serial 1/10 dilutions in the appropriate medium using a fresh pipette at each stage. Direct

counts were made through the microscope using a 0·02-mm. depth Thoma hæmocytometer; dilutions for this purpose were prepared in 0·8 per cent saline and were either counted at once or after storage in ice to prevent cell multiplication.

Results. Sodium sulphide (5 μmol./ml.) added to either a peptone–yeast–glucose medium[6] or to Starkey's medium supplemented with yeast extract[4] permitted full growth of *D. desulphuricans* (Hildenborough strain) in 16–24 hr. with the conventional inoculum. Without sulphide, growth required 2–3 days, though it could be accelerated by using a larger inoculum. The stimulant effect of sodium sulphide has been observed with at least eight other strains; lower concentrations of sulphide were not effective in our experiments.

Dilution counts in either of these media supplemented with sodium sulphide gave results in agreement with the direct count. For example, in a glucose–peptone–yeast medium, dilution counts on a culture containing $(3 \pm 1) \times 10^9$ cells/ml. (direct count) gave counts indicating 10^9 viable bacteria/ml. if sodium sulphide were present, though in its absence counts of 10^4, 10^7 and 10^8 viable cells/ml. were found in three separate series. Sulphide could be replaced by cysteine, ascorbic acid or glutathione, so its effect on growth and viability was due to its reducing properties. Ascorbic acid and glutathione appeared less effective than cysteine or sulphide, and cysteine had the advantage that it could be used in the presence of excess ferrous ions to enable one to detect growth by blackening of the culture due to formation of ferrous sulphide. Dilution counts in media containing cysteine (5 μmol./ml.) plus ferrous ammonium sulphate (1 μmol./ml.) gave results in satisfactory agreement with the direct count using a pure strain of *D. desulphuricans*, and counts on polluted waters indicated populations considerably in excess of those found with unsupplemented media. In two cases sulphate reducers were detected only with cysteine–iron media. In certain natural waters and soils, however, there is a risk that bacteria able to decompose cysteine will liberate hydrogen sulphide and give false results. This counting procedure is being studied further and will be reported in detail elsewhere. The effect of cysteine or sulphide is not directly connected with sulphate reduction, since strains that can grow without sulphate[7] are stimulated if cysteine or sulphide is added to sulphate-free pyruvate media.

Conclusions. Sulphate-reducing bacteria grow much more rapidly if a sufficient concentration of a reducing agent such as cysteine or sulphide is added to the medium. Small populations will often not grow at all without these supplements, so dilution counts, even of large populations, do not measure the population being counted unless a reducing agent is added to each dilution.

Besides providing a reliable method of counting pure populations of *D. desulphuricans*, these observations have several practical consequences relevant to the routine handling of these bacteria.

(i) *Irregularities of growth.* Since sulphide is an end-product of growth in ordinary media, the carry-over of sulphide in the inoculum will determine the rate at which the subculture will grow. In certain cases (a moribund culture, or one from which all sulphide has been removed by alkali in the plug, lead acetate or ferrous salt), the carry-over may be insufficient to allow growth at all. A particular case in which this is important is in the revival of lyophilized cultures, which grow most irregularly unless cysteine or sulphide is added.

(ii) *Effect of ferrous ions.* Excess ferrous salt is often added to a medium in order to detect growth by blackening due to ferrous sulphide, and many workers have noticed casually that growth may occur more readily with excess ferrous ions than without, though this phenomenon does not occur regularly. Since the ferrous ion is a reducing agent, it could act as a stimulant like sodium sulphide or cysteine, and, if the carry-over of sulphide from the parent culture were low, it might have sufficient reducing effect to stimulate growth.

(iii) *Apparent populations of sulphate reducers.* The population of sulphate reducers indicated by dilution counts with unsupplemented media cannot be expected to equal the actual population, and in our experience bears no constant relation to it. Allen[8] mentioned this discrepancy in his studies on sulphate-reducers in sewage, but Heukelekian[2] considered that his counts represented actual populations.

(iv) *Inoculum size.* The rate at which a culture grows in an unsupplemented medium depends on the carry-over both of sulphide and of cells; in media supplemented with cysteine or sulphide it depends only on the number of cells. Hence, in supplemented media, the large inoculum conventionally used with these bacteria is unnecessary. For quantitative work this can be important, as the carry-over of metabolites and end-products in the conventional inoculum must be absurdly large compared with the carry-over in work on other bacteria.

(v) *Aerobic growth.* Butlin, Adams and Thomas[4] showed that addition of ascorbic acid to cultures would permit growth of these bacteria in air. By producing sulphide the sulphate-reducing bacteria create reducing and anaerobic conditions wherever they are active, and, though obligate anaerobes, are thus capable of growth in air if access of air to their immediate environment is slow. They can be grown in air in deep tubes or flasks if a large inoculum is used, or if sulphide is added, and once growth starts it follows diffusion of sulphide throughout the medium. This fact may account for reports of aerobic growth of this organism such as that of Shturm[9].

(vi) *Growth in agar.* The effect of sulphide or cysteine is equally pronounced in media set with agar, and, if sodium sulphide (20 μmol./ml.) is added to the appropriate agar medium, these bacteria can be maintained on the surface of agar slopes protected from oxygen by a pyrogallol plug. Normally it is extremely difficult to grow them on agar slopes. In deep agar 'shake' cultures without sodium sulphide or cysteine, growth of colonies tends to occur in masses: colonies grow more readily if other colonies are near at hand. This phenomenon was noted by Baumann and Denk[10], who ascribed it to diffusion of nutrients from colony to colony. The phenomenon is more likely to be due to diffusion of sulphide, since it can be abolished by addition of cysteine or sulphide to the agar.

The isolation of pure strains can be difficult, since, though in an enrichment the population of *D. desulphuricans* may outnumber the population of contaminants, the proportion that grow in an unsupplemented agar 'shake' may often be less than the proportion of contaminants. The addition of cysteine and iron to agar media has greatly facilitated isolations in our laboratory, since it ensures that all the sulphate reducers present actually form colonies.

In consequence, colonies well separated from contaminant organisms are more readily obtained.

(vii) *Requirement for a reducing agent.* One strain in our laboratory (New Jersey S.W.8, kindly provided by Prof. R. L. Starkey) appears to be unable to grow without a reducing agent. It grows normally in media containing excess ferrous ammonium sulphate, and this can be replaced by cysteine, sodium sulphide or ascorbic acid. We have not succeeded in maintaining it in media without a reducing supplement, even with the conventional large inoculum.

(viii) *Growth with various carbon sources.* The ability of *D. desulphuricans* to grow with various sources of carbon was described exhaustively in the classical work of Baars[11]; Stephenson and Stickland[12] regarded their strain as different from Baars's because of its different 'spectrum' of carbon utilization. Senez[13] studied a strain which would utilize only a few carbon compounds, and Pochon and Chalvignac[14] showed that the ability to utilize carbon sources depended on: (*a*) how long the organism had been subcultured with a single carbon source, and (*b*) whether yeast extract was present in the test media. Our studies have confirmed Pochon and Chalvignac's second point, but have also shown that the presence or absence of sulphide in the test medium influences the results. This observation is well exemplified by tests of carbon utilization by our strain El Agheila *Z*[7,15] which are recorded in Table 1. When cultured with neither yeast extract nor sulphide, the strain grew with very few substrates and required the conventional large inoculum. Addition of sodium sulphide increased the number of substrates utilized and permitted the use of a small inoculum. Addition of yeast extract did not abolish the need for a large inoculum, but increased the range of substrates attacked. With both yeast extract and sodium sulphide, using a small inoculum, a much wider range of substances was attacked. With certain of the carbohydrates, limited growth (presumably utilizing oxidizable carbon in the yeast extract) occurred immediately, but full growth was delayed for many days.

These observations show clearly that growth tests with various sources of carbon in unsupplemented media cannot be used satisfactorily for distinguishing between strains and species of *Desulphovibrio* unless the carry-over of sulphide and nutrients in the inoculum is very carefully defined, and also the presence or absence of other reducing agents such as ferrous ions.

Table 1. Growth of *D. desulphuricans* (Strain El Agheila *Z*), normally cultured in Lactate Medium, in Media containing Various Sources of Carbon in Place of Lactate

All media contained sodium chloride (2·5 per cent), sodium sulphate and other salts at pH 7·6 (see ref. 7). Carbon sources 1 per cent except lactate, pyruvate, malate and ethanol (31 μmol./ml.). Sodium sulphide 5 μmol./ml. when present, yeast extract ('Difco') 0·1 per cent when present. Incubation, 30° C. for 14 days in nitrogen

	No supplement	Sodium sulphide	Yeast extract*	Yeast extract* + sodium sulphide
Inoculum (dry wt./ml.)	2 μgm./ml.	10 mμgm./ml.	2 μgm./ml.	10 mμgm./ml.
Lactate	+	+	+	+
Pyruvate	+	+	+	+
Malate	...	...	+	+
Ethanol	...	...	+	+
Glycerol	−	+	+	+
Glucose	−	−	−	+
Galactose	−	−	−	+
Lactose	−	−	−	+
Maltose	−	−	−	+
Mannitol	−	−	−	−
Acetate	−	−	−	−
No substrate	−	−	−	−

* '+' in these columns indicates growth in excess of that supported by the yeast extract present.

Table 2. Growth of *D. desulphuricans* (Strain Hildenborough) in an Amino-acid Medium with Sulphide in Place of Cysteine

The medium contained glucose (1 per cent), sodium sulphate and other salts (ref. 6) and was inoculated with 1 μgm. dry weight cells/ml. washed by centrifugation in 0·8 per cent sodium chloride. All amino-acids 1 mgm./ml. except cysteine (2 mgm./ml.); sodium sulphide, 10^{-3} *M*. Incubation, 30° C. for four days in hydrogen + 5 per cent carbon dioxide

Supplement	Growth (μgm. dry wt./ml.)
—	0
Cysteine, serine, ornithine + *iso*-leucine	115
Sodium sulphide, serine, ornithine + *iso*-leucine	120

(ix) *Cysteine requirement.* Postgate[6] reported that the growth of the Hildenborough strain of *D. desulphuricans* was stimulated by a mixture of four amino-acids, of which cysteine was the most important as their effect could not be observed in its absence. In the light of the observations reported above, it was possible that cysteine was not acting as a nutrient at all, but merely stimulating growth with the other three amino-acids through its reducing properties. We have shown that this is, in fact, true: Table 2 indicates that the improved growth found in an allotrophic medium supplemented with cysteine, serine, ornithine and *iso*-leucine was also obtained if cysteine was replaced by approximately equimolar sodium sulphide.

We are indebted to Mr. K. R. Butlin for his advice and interest. This paper is published by permission of the Director, Chemical Research Laboratory.

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NARCOTICS AND BIOLOGICAL ACETYLATIONS

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MUCH evidence[1] has accumulated to show that narcotics, at the low concentrations that produce narcosis *in vivo*, inhibit certain respiratory processes, particularly those involved in carbohydrate oxidation, in the nervous system and in other tissues. This has led to the view that narcosis may result from a suppression of certain respiratory events at the nervous centres where the narcotics are absorbed. On the other hand, Larrabee *et al.*[2] have pointed out that in experiments on resting neurones the functional

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effects of narcotics are apparently unaccompanied by a measurable retardation of the rate of oxygen consumption. With stimulated nerves, however, the inhibitory effects of a narcotic, such as chloretone, on the increased oxygen uptake are in proportion to their inhibitory effects on synaptic transmission. Bronk and Brink[3] have shown that the rate of oxygen uptake by resting (frog) nerve is reduced 15 per cent by 0·002 *M* chloretone, but that the increment in the rate of oxygen uptake obtained with nerves carrying impulses at the rate of 50 impulses/sec. is decreased by 50 per cent by the same quantity of narcotic. They conclude that the narcotic inhibits an enzyme in a reaction located between the oxidative reaction directly affected by the impulses and the reaction using oxygen.

It is important to realize, in our attempts to interpret the effects of drugs on metabolic processes, that it may be possible to impede a step in a chain of respiratory events, each of which contributes to the total quantity of oxygen consumed, without a large, or even measurable, effect on the rate of oxygen consumption by the cell, so long as the enzymes involved in the reactions following the impeded step are still saturated with their substrates. The step impeded, however, may be closely associated with a metabolic reaction directly involved in the functional activity of the cell.

It is proposed to show in this article that narcotics at low concentrations impede the oxidative synthesis of adenosinetriphosphate and, thereby, affect the rates of acetylation processes dependent on the presence of this substance. Eiler and McEwen[4] have already shown that pentobarbital inhibits the generation of high-energy phosphate bonds to the extent that it interferes with oxygen utilization. Brody and Bain[5] have, indeed, postulated that uncoupling of phosphorylation from oxidation may be connected with the narcotic action of barbiturates; but it will be shown, elsewhere[6], that the effects of narcotics on phosphorylations are quite different from those of a typical uncoupling agent such as 2 : 4 dinitrophenol.

Experimental Procedure

The experimental work, carried out with the conventional Warburg apparatus at 37° C., involved a study of the effects of narcotics on rates of biological acetylations. These were brought about by various tissue preparations described as follows.

Pigeon liver acetone powder. Livers from freshly killed pigeons were minced and homogenized in the presence of acetone for 60 sec. in a Waring blendor. The homogenate was added to ten volumes of acetone (at 0° C.). After five minutes the dehydrated material was filtered on a Buchner funnel and washed with cold acetone. Drying of the powder was completed in a vacuum desiccator (over calcium chloride), where it was stored at 0° C.

Pigeon liver extract. The acetone-dried powder was extracted by grinding it for five minutes with 0·15 *M* potassium fluoride in the proportion of 60 mgm. of powder to 0·8 ml. of extraction medium. After centrifugation at 19,000 *g* for five minutes, the supernatant was filtered through glass wool, and 0·8 ml. of extract was pipetted directly into a manometer vessel.

Rat brain homogenate. A 25 per cent homogenate of rat brain was prepared by homogenizing the cerebral hemispheres in a solution composed of 0·06 *M* potassium chloride, 0·04 *M* nicotinamide, and 0·04 *M* magnesium chloride. 0·5 ml. homogenate was added to the manometer vessel.

In addition to pigeon liver extract and rat brain homogenate, the vessels contained 200 μgm. sulphanilamide, 0·02 *M* sodium phosphate buffer, *p*H 7·5, and other additions, as will be indicated, to a total volume of 3 ml. After five minutes of thermal equilibration, the measurement of oxygen uptake was commenced, carbon dioxide being absorbed by potassium hydroxide in the centre well of the manometric vessel. All the experiments were carried out in the presence of air.

Rat brain mince. Rat brain (cerebral hemispheres) was minced with a small Latapie mincer and suspended in a solution of 0·006 *M* nicotinamide, 0·15 *M* potassium chloride, and 0·02 *M* magnesium chloride, to make a 50 per cent suspension. 1 ml. of suspension was added to the manometric vessels after all other additions had been made. All the vessels contained the following substances (final concentrations) to a total volume of 3 ml.: sodium phosphate buffer, *p*H 7·4, 0·02 *M*; sodium fluoride, 0·03 *M*; choline chloride, 0·001 *M*; eserine sulphate, 0·0004 *M*; 0·2 ml. of 20 per cent potassium hydroxide in the centre well.

Extracts of beef brain. Acetone-dried beef brain was prepared according to the methods of Harpur and Quastel[7]. The acetone-dried brain powder was extracted by grinding it in a mortar with the following solution: nicotinamide, 0·08 *M*; neutral cysteine, 0·03 *M*; potassium chloride, 0·09 *M*; and magnesium sulphate, 0·012 *M*. After centrifuging for five minutes at 19,000 *g*, the supernatant was filtered through glass wool, and 1 ml. of the extract (equivalent to 60 mgm. of powder) was added to the manometric vessel after all other additions had been made. The vessels also contained the following salts (final concentrations) to a total volume of 3 ml.: sodium bicarbonate, 0·047 *M*; choline chloride, 0·0008 *M*; sodium phosphate buffer, *p*H 7·5, 0·01 *M*; eserine sulphate, 0·0003 *M*.

Methods of analysis. Acetylcholine was estimated by measuring the contractions of the dorsal muscle of the leech suspended in an aerated medium[8] of the following composition: sodium chloride, 0·71 per cent; potassium chloride, 0·032 per cent; calcium chloride, 0·018 per cent; sodium bicarbonate, 0·012 per cent; and glucose, 0·077 per cent. All the results are in terms of acetylcholine chloride. Phosphate esters were removed from the samples to be assayed by the procedure of Harpur and Quastel[7].

Sulphanilamide was estimated by the method of Bratton and Marshall[9]. Acetylated sulphanilamide was determined by difference.

Effects of Narcotics on Acetylation

Effects of chloretone and adenosinetriphosphate. The addition of pigeon liver extract to rat brain homogenate produces a system which readily acetylates sulphanilamide under aerobic conditions. Rat brain homogenate alone is incapable of sulphanilamide acetylation, and does not hydrolyse acetylsulphanilamide. The results of a typical experiment, shown in Table 1, indicate the increase in acetylation obtained when acetate or pyruvate is added to the brain–liver system. It will be seen that pyruvate is more effective than acetate as an acetyl precursor for sulphanilamide acetylation, and that pyruvate, unlike acetate, gives rise to increased oxygen uptake. The addition of chloretone (0·004 *M*) reduces both

Table 1. Effect of chloretone on respiration and sulphanilamide acetylation by a mixture of rat brain homogenate and pigeon liver extract at 37° C. in air

Additions	Oxygen uptake (μl.)	Inhibition of respiration (per cent)	Sulphanilamide acetylated (μgm.)	Inhibition of acetylation (per cent)
Nil	183	—	36	—
Chloretone (0·004 *M*)	52	71	27	25
Sodium acetate (0·02 *M*)	185	—	81	—
Sodium acetate (0·02 *M*) + chloretone (0·004 *M*)	36	81	27	66
Sodium pyruvate (0·02 *M*)	345	—	108	—
Sodium pyruvate (0·02 *M*) + chloretone (0·004 *M*)	37	90	27	75

Vessel contents: 0·5 ml. rat brain homogenate and 0·8 ml. pigeon liver extract; sodium phosphate buffer, pH 7·5 (0·02 *M*); 200 μgm. sulphanilamide; and additions shown in table. Total volume, 3 ml.

Table 2. Effect of adenosinetriphosphate (ATP) in relieving the chloretone inhibition of sulphanilamide acetylation in a mixture of rat brain homogenate and pigeon liver extract in the presence of sodium acetate (0·02 *M*) at 37° C.

Additions	Oxygen uptake (μl.)	Chloretone inhibition of oxygen uptake (per cent)	Sulphanilamide acetylated (μgm.)	Chloretone inhibition of acetylation (per cent)
Nil	356	—	87	
Chloretone (0·004 *M*)	143	60	27	70
ATP (0·003 *M*)	345	—	121	—
Chloretone (0·004 *M*) + ATP (0·003 *M*)	158	54	87	28

Vessel contents: as in Table 1, with diphosphopyridine nucleotide (0·00025 *M*) and additions shown above. Total volume, 3 ml. Experimental time, 90 min.

respiration and acetylation to low levels (Tables 1 and 2).

In the presence of added adenosinetriphosphate the extent of chloretone inhibition of acetylation is considerably diminished, while the rate of respiration is much less affected. A typical experimental result is shown in Table 2. It seems, therefore, that chloretone, by its inhibitive action on a respiratory process, inhibits the formation of adenosinetriphosphate and, therefore, the rate of synthesis of acetylsulphanilamide. The actual acetylating process is clearly far less affected by the narcotic, otherwise a relieving effect of adenosinetriphosphate would not be demonstrable.

Whereas adenosinetriphosphate, however, is effective in mainly overcoming the narcotic inhibition of acetylation in the presence of acetate, this is not the case when acetate is replaced by pyruvate (Table 3). Only a relatively small relief of the inhibition takes place. This is understandable, for as narcotics inhibit the pyruvic oxidase system in brain tissue[10–12], less oxidation of pyruvate occurs in the presence of the chloretone. There results, therefore, a diminution in the rate of formation of 'active acetate' required for acetylation purposes. The limiting factor becomes the availability of 'active acetate', and the addition of adenosinetriphosphate, under the given experimental conditions, influences this availability only to a small extent.

Sulphanilamide acetylation by pigeon liver extracts. Crude cell-free extracts of acetone-dried pigeon liver give rise to a high rate of sulphanilamide acetylation in the presence of acetate and adenosinetriphosphate. These extracts are also capable of a dismutation of pyruvate whereby 'active acetate' can be generated from pyruvate and produce acetylations in the absence of added adenosinetriphosphate. The acetylation is not due to residual adenosinetriphosphate in the crude extract, since the addition of acetate alone to the extract produces no appreciable increase in the rate of acetylation.

The results given in Table 4 show the effects of narcotics on the anaerobic acetylation of sulphanilamide by the cell-free extracts. No respiration takes place in these systems. The results indicate that the narcotics employed have no measurable effect on the rate of sulphanilamide acetylation. It may be concluded that the enzymes involved in the acetylation of sulphanilamide are not inhibited by narcotics even when these are present at relatively high concentrations. Furthermore, it is apparent that narcotics do not interfere with the utilization of adenosinetriphosphate. This is consistent with the fact that narcotics do not impede glycolysis, a process involving the utilization of this high-energy phosphate (Table 6).

Aerobic acetylation of choline by rat brain mincé. Typical results of experiments dealing with the effects of narcotics on respiration and the acetylation of choline by rat brain mince are shown in Table 5. The addition of pyruvate increases the oxygen uptake, for example, by 109 per cent, this being accompanied by a 70 per cent increase in the rate of synthesis of acetylcholine. In all cases, the addition of the narcotic gives rise to a marked inhibition of the rates of oxidation and acetylation. It will be seen that the addition of adenosinetriphosphate increases the rate of acetylation of choline in the presence of the narcotic. It is clear, therefore, that the narcotic does not impede the utilization of the added adenosinetriphosphate; nor does it affect the choline acetylating system. The inhibition of choline acetylation by the aerobic respiring system is due, probably, to the suppression of adenosinetriphosphate formation, thus accounting for the parallelism between the percentage inhibitions of respiration and acetylation shown in the results given in Table 5.

Acetylcholine synthesis by beef brain extracts. The lack of inhibitory effect of narcotics on acetylcholine synthesis by cell-free extracts of beef brain is illustrated by the typical experimental results given in Table 6. It will be seen that a high concentration of 'Narconumal' (5-allyl-5-*iso*propyl-N-methyl barbituric acid) has no effect on acetylcholine synthesis by an extract of beef brain undergoing a high rate of glycolysis. This is also apparent in experiments where citrate is used as the acetyl donor and where the only high-energy phosphate available to the system is the adenosinetriphosphate initially added.

Harpur and Quastel[7] have shown that glucose does not inhibit acetylcholine synthesis by brain extracts,

Table 3. Effect of chloretone and adenosinetriphosphate on oxidation and sulphanilamide acetylation by a mixture of rat brain homogenate and pigeon liver extract in the presence of sodium pyruvate (0·02 *M*) at 37° C.

Additions	Oxygen uptake (μl.)	Inhibition of oxygen uptake (per cent)	Sulphanilamide acetylated (μgm.)	Inhibition of acetylation (per cent)
Nil	425	—	95	—
Chloretone (0·004 *M*)	103	76	14	85
ATP (0·002 *M*)	443	—	122	—
Chloretone (0·004 *M*) + ATP (0·002 *M*)	153	65	32	77

Vessel contents: as in Table 1, with sodium pyruvate (0·02 *M*), and additions shown above. Total volume, 3 ml. Experimental time, 90 min.

Table 4. Effect of narcotics on the acetylation of sulphanilamide by pigeon liver extract at 37° C.

Expt.	Gas phase	Substrate	Narcotic	ATP conc.	Sulphanilamide initially added (μgm.)	Sulphanilamide acetylated (μgm.) without narcotic	Sulphanilamide acetylated (μgm.) with narcotic
1	Air	Pyruvate (0·02 *M*)	Nembutal ($9·6 \times 10^{-4}$ *M*)	—	202	76	76
2	N_2/CO_2	Pyruvate (0·02 *M*)	Chloretone (4×10^{-3} *M*)	—	211	121	108
3	Air	Pyruvate (0·02 *M*)	Chloretone (4×10^{-3} *M*)	0·003 *M*	213	137	137
4	Air	Acetate (0·02 *M*)	Chloretone (4×10^{-3} *M*)	0·003 *M*	101	93	95
5	N_2/CO_2	Acetate (0·02 *M*)	Chloretone (5×10^{-3} *M*)	0·0045 *M*	211	193	195
6	N_2/CO_2	Acetate (0·02 *M*)	Nembutal ($1·2 \times 10^{-4}$ *M*)	0·003 *M*	200	155	146
7	Air	Acetate (0·02 *M*)	Pentothal (8×10^{-4} *M*)	0·003 *M*	202	139	130
		Acetate (0·02 *M*)	Amytal (8×10^{-3} *M*)	0·003 *M*	202	139	132
8	N_2/CO_2	Acetate (0·02 *M*)	Hyoscine (5×10^{-3} *M*)	0·003 *M*	202	153	148

Pigeon liver powder extracted with potassium fluoride (0·15 *M*) and magnesium chloride (0·02 *M*). Media: 1 ml. of liver extract (= 60 mgm. powder). Sodium phosphate buffer, *p*H 7·5 (0·02 *M*); diphosphopyridine nucleotide (5×10^{-4} *M*) added in experiments 2 and 3. When the gas phase is N_2/CO_2, sodium bicarbonate (0·023 *M*) is added, and vessels gassed for 10 min. with 93 per cent N_2/7 per cent CO_2. Total volume, 3 ml. Experimental time, 90 min.

Table 5. Effects of narcotics on respiration, and acetylation of choline, by rat brain mince at 37° C.

Expt.	Pyruvate concentration	Narcotic	ATP conc.	Oxygen uptake μl.	Per cent inhibition of respiration by narcotic	Choline acetylated μgm./gm. tissue	Per cent inhibition of acetylation by narcotic
1	Nil	—	—	420	—	10	—
	0·01 *M*	—	—	866	—	17	—
	0·01 *M*	'Narconumal'		498	43	11	35
	0·01 *M*	—	0·002 *M*	745	—	20	—
	0·01 *M*	'Narconumal'	0·002 *M*	539	28	18	10
2	0·03 *M*	—	—	928	—	12	—
	0·03 *M*	Chloretone	—	170	81	5	59
	0·03 *M*	—	0·002 *M*	1,028	—	18	—
	0·03 *M*	Chloretone	0·002 *M*	307	70	10	44

Experimental conditions as described in the text. 'Narconumal' concentration, 0·004 *M*; chloretone concentration, 0·005 *M*. Time, 2 hr. Gas phase, air.

providing that conditions are present which allow glycolysis to take place. Under these conditions, the adenosinetriphosphate used in phosphorylating glucose is more than returned to the system. However, any interference with the phosphorylation mechanism associated with glycolysis would be reflected in a reduced acetylcholine synthesis. The fact that no inhibition of acetylcholine synthesis takes place indicates that the generation of adenosinetriphosphate in the course of anaerobic glycolysis is unaffected by the narcotic at the relatively high concentration used.

Conclusions

These results show that an inhibition of respiration brought about by a narcotic is accompanied by a decreased rate of acetylation, and that the addition of adenosinetriphosphate to an aerobic system alleviates the narcotic effect on acetylation. The effect of added adenosinetriphosphate indicates that the narcotic inhibition of acetylation is the result of a suppression of the oxidative synthesis of this ester. Furthermore, it is apparent that narcotics at high concentrations affect neither the acetylating enzymes *per se*, nor the pyruvate dismutation system, nor the glycolytic sequence in beef brain extract. Thus, the narcotics do not inhibit the utilization of adenosinetriphosphate in these metabolic processes.

McLennan and Elliott[13] have postulated a direct effect of narcotics on the choline acetylating system to account for their results on acetylcholine synthesis, but our findings are opposed to such a conclusion. The underlying effect, which accounts satisfactorily for the results that have been described, is a narcotic-induced inhibition of the oxidative synthesis of adenosinetriphosphate. This is a phenomenon that must be concerned with the functional activity of the nerve cell, if acetylcholine, for example, plays the essential part in the nervous system which is claimed for it.

Table 6. Effect of narcotics on the anaerobic acetylation of choline by beef brain extracts at 27° C.

Expt.	Additions	μ*M* carbon dioxide output (glycolysis)	Acetylcholine synthesis (μgm./gm. powder)
1	Nil	0·2	28
	'Narconumal' (0·006 *M*)	0·3	28
	Glucose (0·03 *M*)	43·5	134
	Glucose + 'Narconumal'	43·5	134
2	ATP (0·002 *M*)		35
	Sodium citrate (0·02 *M*) + ATP		150
	'Narconumal' (0·006 *M*) + ATP		35
	Sodium citrate (0·02 *M*) + ATP + 'Narconumal'		150

Vessel contents: 1 ml. of beef brain extract (= 60 mgm. powder) prepared as described in the text. Sodium bicarbonate (0·047 *M*), sodium phosphate buffer, *p*H 7·5 (0·01 *M*), choline chloride (0·0008 *M*), eserine sulphate (0·0003 *M*). Expt. 1 also contained diphosphopyridine nucleotide (5×10^{-4} *M*) and ATP (0·001 *M*); expt. 2 contained sodium fluoride (0·03 *M*). All gassed for 10 min. with 93 per cent N_2 and 7 per cent CO_2. Time, 1 hr. + 15 min. equilibration.

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LETTERS TO THE EDITORS

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Sulphur-containing Amino-acids of Nisin

In a recent publication[1], we reported that a preparation of the antibiotic nisin could be resolved into at least four active polypeptides, which all yielded on hydrolysis two sulphur-containing amino-acids not normally found in proteins. These amino-acids behaved like lanthionine and cystathionine on two-dimensional paper chromatograms, and treatment of a mixture of them with Raney nickel yielded two substances which behaved like alanine and α-amino-*n*-butyric acid.

The amino-acid which behaved like cystathionine has now been isolated and found to differ from cystathionine.

An acid hydrolysate of crude nisin was evaporated to dryness, the residue dissolved in water and the *p*H of the solution adjusted to 5·0. On standing at 4° C. a precipitate appeared which consisted mainly of leucine and valine. Addition of ethanol to the supernatant resulted in the precipitation of mixtures of lanthionine and the cystathionine-like substance. Fractional crystallization of these precipitates from water gave mainly lanthionine, while the other amino-acid remained in solution. The latter was precipitated by addition of ethanol and recrystallized from aqueous ethanol. Found: C, 35·4; H, 6·5; N, 11·3 per cent. $C_7H_{14}O_4N_2S,H_2O$ requires: C, 35·0; H, 6·7; N, 11·6 per cent.

Although this substance behaved like cystathionine on two-dimensional paper chromatograms, it was much more soluble than L-cystathionine in water. Dr. F. Gibson, of the Department of Microbiology, Oxford, found that it did not support the growth of mutant strains of *Bact. coli* which grew under similar conditions in the presence of a mixture of synthetic L-cystathionine and L-*allo*cystathionine. Moreover, it did not behave like cystathionine on a column of 'Dowex-50' (15 cm. × 0·9 cm.) when elution was carried out with the buffers used by Stein and Moore[2]. Lanthionine and cystathionine were readily separable on this column, the former emerging after only 12 ml. of the first buffer (*p*H 3·42) had passed through, and the latter requiring the passage of all the first buffer (34 ml.) and 13 ml. of the second buffer (*p*H 4·25) for elution. When a mixture of the two sulphur-containing amino-acids from nisin (precipitated from a hydrolysate as already described, but not fractionated) was run on the column, a well-isolated strong band corresponding to lanthionine was eluted; but no cystathionine appeared. Paper chromatography indicated that the cystathionine-like amino-acid was still present in the band containing the lanthionine.

These facts indicated that the substance was a structural isomer of cystathionine. This view was supported by the finding that it resembled lanthionine and differed from cystathionine in yielding a coloured solution ($E_{max.}$ = 450 mμ), when treated with the Chinard reagent[3]. This reagent has been used as a test for ornithine ($E_{max.}$ = 515 mμ); but it shows a weaker colour with lysine ($E_{max.}$ = 450 mμ), and it is of interest that lysine and lanthionine contain the same number of atoms between their two amino-groups.

The nisin polypeptides resemble the antibiotic subtilin, which has been shown to contain lanthionine and an amino-acid having the formula[4,5] $C_7H_{14}O_4N_2S$. We are grateful to Dr. J. C. Lewis, of the Western Regional Research Laboratory, U.S.A., for a specimen of this compound. X-ray powder photographs, kindly taken by Dr. D. Hodgkin and Mrs. M. Webster, of the Department of Crystallography, Oxford, have shown that it is identical with the corresponding amino-acid from nisin.

The C_7 amino amino-acid from subtilin has been found by Alderton[6] to yield L-alanine and D-α-amino-*n*-butyric acid on treatment with Raney nickel. However, the compound differs from L-*allo*cystathionine in having a higher optical rotation[6]. Alderton has therefore proposed that it is one of the β-methyllanthionines[6]. We conclude that this is also the structure of the amino-acid from nisin which was not distinguished from cystathionine by paper chromatography. It is of interest that nisin and subtilin both appear to contain β-methyllanthionine and lanthionine in the ratio of 4 : 1, although they differ in their content of other amino-acids[1,5]. These sulphur-containing amino-acids may also be present in a third polypeptide antibiotic, called cynnamycin, which has been obtained from *Streptomyces cinnamoneus*[7].

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The Fibrin Serum Factor

Until recent years, it was rather generally believed that the structure of a fibrin clot is held together by primary chemical bonds, as indicated, for example, by its failure to dissolve in concentrated neutral urea solutions. It is now known that fibrin can be prepared in two different forms, one of which contains much stronger bonds than the other. The latter is obtained from highly purified fibrinogen and thrombin; the former is prepared in the presence of small amounts of calcium salt and a yet unidentified component of serum. The fibrin prepared from purified components is soluble in dilute acid[1], neutral urea or neutral guanidine hydrochloride solution[2], or neutral solutions of lithium chloride, lithium bromide, sodium bromide and sodium iodide[3,4]. The fibrin with calcium and serum factor is resistant to all these reagents. The greater bond-strengths found in this fibrin compared with those in the clot obtained in the absence of calcium and serum factor are also shown by its higher rigidity and much slower stress relaxation[5]. This serum factor seems to be of protein nature, and is precipitated with fibrinogen in half-saturated ammonium sulphate, but not on isoelectric (*p*H 5·2–5·4) precipitation[6]. The purpose of the present communication is to report that this factor can be removed from fibrinogen prepara-

tions by exposure to several reagents, and that it can be restored by use of a purified albumin fraction.

Bovine Fraction I (Armour) was refractionated by a method essentially that described by Laki[7]; this consists of taking the supernatant solution from a low temperature, low ionic strength treatment and precipitating with 23 per cent saturation of ammonium sulphate. The *p*H is at all times above 5·9. The product generally has a clottability of 94–98 per cent; but, even at the highest degree of purity, serum factor is still present, since addition of calcium alone, usually employed at 0·001 *M*, will make the fibrin insoluble in urea solution. If the fibrinogen solution is exposed by dialysis to 3·0 *M* urea or to 2·0 *M* sodium bromide, the serum factor is destroyed, and addition of even 0·01 *M* calcium will not make the clot insoluble in urea. It should be mentioned that Loewy and Edsall have also observed the inactivation of factor activity by urea[8]. The experimental details are as follows. The buffer used as diluent and as solvent for the various proteins and the urea consists of 0·40 ionic strength sodium chloride plus 0·05 ionic strength sodium phosphate, giving *p*H 6·2. The sodium bromide reagent is dissolved in water. A 1–2 per cent fibrinogen solution is dialysed with constant stirring, against a large volume (changed once) of 3·0 *M* urea or 2·0 *M* sodium bromide for 6–8 hr. or 1–2 hr., respectively, at room temperature (23–26° C.), following which the reagent is removed by dialysis at 0° C. for 15–20 hr. against several changes of the 0·45 ionic strength buffer. Control samples are dialysed in a similar manner against the 0·45 ionic strength buffer. During none of these dialyses does precipitation or even opalescence appear in the samples. Ultracentrifugal patterns of material treated similarly show no change in the appearance of the single sharp peak seen[3,4]. Hence no appreciable damage seems to occur to the fibrinogen. Samples are then clotted at 4 gm./l. fibrinogen, 1 unit/ml. thrombin, *p*H 6·2, ionic strength 0·45, and with or without 0·001 *M* calcium chloride. Each clot is tested by addition of an equal volume of 3·0 *M* urea, giving a final urea concentration of 1·5 *M*. Of the clots containing calcium, the control samples remain unchanged, whereas the samples formed from treated fibrinogen dissolve.

Since the serum factor cannot be found in the supernatant solution resulting from an isoelectric precipitation of factor-free fibrinogen[5], it may be deduced that this procedure also results in destruction of the factor rather than separation. In agreement with this conclusion is the additional finding that isoelectric precipitation frequently fails to give factor-free fibrinogen[5]. This may simply reflect a variability in the extent of exposure to the acidic environment. This factor is thus very delicate, being destroyed by mild exposure to acid, urea or sodium bromide.

It was also discovered that the serum factor activity could be restored merely by addition of a solution of bovine serum albumin (Armour Fraction V). So little as 0·05–0·10 per cent albumin in the final clot suffices to render it insoluble in urea. It was found, however, that the addition of albumin was sometimes ineffective, and this seemed to be the result of having over-exposed the fibrinogen to the reagent. This is especially a difficulty in using the sodium bromide. It suggests either that serum factor contains two components, one of which is more stable and does not occur in the albumin fraction, or that some minor alteration finally occurs in the fibrinogen, eliminating sites where reaction with serum factor occurs.

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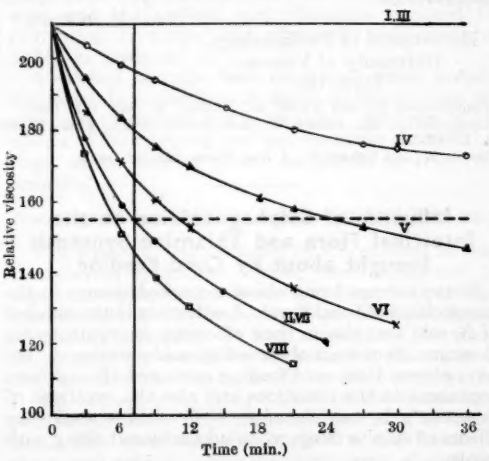
Inhibition and Activation of Lysozyme

IN a previous communication, Pantlitschko and I discussed the inhibition and activation of the hyaluronic acid – hyaluronidase system[1]. It was possible to demonstrate the inhibiting action of electronegatively charged chain molecules (heparin, sulphonated hyaluronic acid, sulphonated carboxy-cellulose, etc.) on one hand and the activating action of electropositively charged macromolecules (histone, protamine, peptone, etc.) on the depolymerization of hyaluronic acid under the influence of hyaluronidase, on the other hand. Bergamini and Ferrari[2] discussed in 1948 the inhibiting action of sulphonated macromolecules (heparin, 'Liquoid', etc.) on lysozyme activity, employing a turbidimetric method. It was thought of interest to verify the results of these authors with the much more accurate viscosimetric method developed by Meyer and Hahnel[3], and to investigate at the same time the influence of electropositively charged macromolecules.



Influence of heparin and histone on the activity of lysozyme. Substrate: carbohydrate fraction from *Micrococcus lysodeikticus* (0·2 per cent solution in water); buffer: McIlwaine (*p*H 5·3) + 0·35 per cent sodium chloride; enzyme: lysozyme (Armour, Inc.); Ostwald viscosimeter, — 37°. I, Initial viscosity (substrate with and without heparin, histone, respectively); II, normal depolymerization curve; III, heparin $1 \cdot 4 \times 10^{-3}$; IV, heparin $5 \cdot 0 \times 10^{-4}$; V, heparin $1 \cdot 0 \times 10^{-4}$; VI, heparin $5 \cdot 0 \times 10^{-5}$; VII, histone $1 \cdot 0 \times 10^{-3}$; VIII, histone 1×10^{-3}

Substance	Lysozyme		Hyaluronidase	
	Inhibition (per cent)	Activation (per cent)	Inhibition (per cent)	Activation (per cent)
Heparin				
$1 \cdot 4 \times 10^{-4}$	100·0	—	100·0	—
$5 \cdot 0 \times 10^{-4}$	80·0	—	65·0	—
$1 \cdot 0 \times 10^{-4}$	45·3	—	37·5	—
$5 \cdot 0 \times 10^{-5}$	19·1	—	6·1	—
Histone				
$1 \cdot 0 \times 10^{-2}$	—	22·2	—	42·0
$7 \cdot 0 \times 10^{-3}$	—	0	—	32·1
$1 \cdot 0 \times 10^{-3}$	—	0	—	4·0

Enzyme activity was studied by the viscosimetric method described by Meyer and Hahnel[3] (see graph). Heparin inhibits lysozyme activity up to a concentration of about 5×10^{-5}. Histone, protamine and peptone are active as activators up to a concentration of about 1×10^{-2}; smaller concentrations are without influence.

When inhibition and activation are calculated by the formulæ developed earlier by us[1], a quantitative estimate is possible (see table; for comparison the respective values for hyaluronidase are also given).

It can be seen from the table that the inhibiting action of heparin on lysozyme and hyaluronidase is of the same order, though the action of lysozyme is inhibited somewhat more. The activating effect of histone and protamine on lysozyme is less pronounced. Concentrations of $1 \cdot 0 \times 10^{-2}$ and $7 \cdot 0 \times 10^{-3}$ show 4 and 32 per cent activation of action of hyaluronidase. These concentrations are without influence on the activity of lysozyme. A concentration of $1 \cdot 0 \times 10^{-2}$ histone is required to show activation of lysozyme.

We are indebted to the State of New York Department of Health (Albany) and to Prof. Favilli (Bologna) for cultures of *Micrococcus lysodeikticus*. For procuring the necessary amount of crystalline lysozyme preparation our thanks are due to Mr. Engelskind, representative in Vienna of the Armour Laboratories.

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Influence of Sulphaguanidine on the Intestinal Flora and Thiamine Synthesis brought about by Curd Feeding

Sulpha drugs bring about a marked change in the composition of fæcal flora[1]. A reduction in the number of *B. coli*, and also in their efficiency for synthesizing thiamine, have been observed by many workers[2]. We have shown that curd feeding enhanced the coliform organisms in the intestines and also the synthesis of thiamine[3]. It was therefore of interest to study the effects of sulpha drugs when administered along with curds.

Eighteen albino rats, consisting of equal numbers of males and females and weighing 80–100 gm., were fed a vitamin B_1-free basal diet for one week, after which period the urine and fæces of the individual rats were collected with the usual precautions and thiamine was determined[4]. The rats were then given sulphaguanidine (0·25 gm. per rat daily) along with the thiamine-free basal diet. A week later, urine and fæces were collected for three days to assess the lowering in thiamine synthesis due to sulphaguanidine feeding.

After a week's rest to overcome the effects of the sulpha drug, the rats were divided into two comparable groups; one group was given 10 γ of synthetic vitamin B_1 and the other 13 gm. of curd containing 5 γ vitamin B_1 plus 5 γ synthetic vitamin B_1. Three rats in each group were employed for determining the *B. coli* content of the fæces, and the other six rats were used for thiamine-excretion studies. When the rats had been on the diet for a week, urinary and fæcal collections were made. Both groups then received sulphaguanidine (0·25 gm. per rat daily), and a week later urine and fæces were collected. The *B. coli* in the fæces were also enumerated. The average values of thiamine excreted in the different cases stated above and the *B. coli* count are presented in the accompanying table.

Period of the diet	Total daily thiamine excretion (γ) in Urine	Fæces	*B. coli* count
Basal B_1-free diet	1·14	1·08	—
Basal B_1-free diet + 0·25 gm. sulphaguanidine	0·42	0·06	—
Basal diet + 10 γ synthetic B_1	1·97	1·48	$2 \cdot 8 \times 10^5$
Basal diet + 13 gm. curd + 5 γ synthetic B_1	3·18	3·62	$9 \cdot 6 \times 10^4$
Basal diet + 10 γ synthetic B_1 + 0·25 gm. sulphaguanidine	1·33	0·24	$1 \cdot 5 \times 10^5$
Basal diet + 13 gm. curd + 5 γ synthetic B_1 + 0·25 gm. sulphaguanidine	2·67	2·76	$6 \cdot 0 \times 10^4$

The results clearly show that with 13 gm. of curds, accounting for only 5 γ of vitamin B_1, the urinary and fæcal excretion of thiamine is considerably more than in the corresponding animals receiving 10 γ of synthetic vitamin. This is in conformity with our earlier findings. The reduction in thiamine excretion when sulphaguanidine is fed is much higher in the synthetic thiamine group than in the curd group. The coliform organisms in the curd group have not suffered so great a decrease as the other group, indicating that curd-feeding results in developing sulpha drug antagonism similar to that when *p*-aminobenzoic acid is administered. These observations have a fundamental and practical importance in nutrition, more especially in the case of persons who generally take curds or buttermilk with every meal.

Further work is being carried out. We desire to record our thanks to Dr. K. V. Giri for his interest in this investigation.

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Recovery of Caprinized and Lapinized Rinderpest Viruses from Condensed Water Vapour removed during Desiccation

Stein and Rogers[1] demonstrated the presence of Newcastle disease virus in the condensed water vapour removed during desiccation of material containing that virus. They failed to demonstrate the presence of vesicular stomatitis, equine encephalomyelitis, equine infectious anæmia and swine fever viruses under similar conditions.

The necessity arose for the desiccation of material containing virulent rinderpest virus in an Edwards's centrifugal freeze-dryer, normally used for desiccation of caprinized and lapinized rinderpest virus vaccines for field use. Possible contamination of the machine by virulent virus in the condensed water vapour was a factor which had to be considered. Caprinized and lapinized viruses were used to study the problem.

Spleen pulp, harvested from reacting goats, was processed in wide-mouthed tubes covered with single-layer lint sterility caps. After ten hours processing, the refrigerated coils were permitted to warm up and the condensed water vapour was collected as it drained from the exhaust valve of the condenser chamber. 5 ml. of this condensate was inoculated subcutaneously into each of four susceptible bullocks. These animals showed typical caprinized virus reactions after four to five days. One animal died on the eleventh day due to intercurrent disease. Fourteen days after inoculation the remaining animals were challenged with caprinized virus. They showed no reaction to the challenge dose whereas two susceptible controls reacted typically. The experiment was repeated with four more bullocks. Three gave typical thermal reactions while the remaining one was unaffected. On challenge, all four proved to be immune and three control animals responded thermally.

In both experiments the results indicated the presence of caprinized rinderpest virus in the condensate.

Similar results were obtained using lapinized rinderpest virus. Of six rabbits inoculated intravenously with 1 ml. of condensate, five showed the usual temperature rise within 60 hr.; the remaining one showed no reaction. Two of the reacting rabbits were killed after 96 hr. and were found to have typical lesions on post-mortem examination. After ten days the remaining four rabbits were challenged with lapinized virus. Three showed no reaction, whereas the fourth responded with a mild rise in temperature. Two control animals reacted normally. The results show that lapinized virus was present in the condensed water vapour removed during desiccation.

This work has not been repeated with virulent rinderpest virus; but it seems most probable that it could be recovered in the same manner. The necessity for collecting the condensed water vapour into disinfectant and for disinfection of the machine are apparent. It is thought that the major part of the virus in the condensate is carried over during the period of evaporative freezing when dissolved gases and water vapour are removed rapidly as indicated by the rise of condenser temperature from − 45° C. to the region of − 20° C. or higher. In this period approximately 20 per cent of the original water content is removed. Once frozen, desiccation of the material becomes considerably slower.

It has not proved possible to demonstrate the presence of either of the test viruses in material obtained by swabbing the walls of the desiccating chamber after processing.

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Indirect Determination of Water Retention in Cattle as a means of estimating Energy Exchange

The starch equivalent or net energy system, which is the basis of livestock rationing in Great Britain, measures the nutritive value of feeds in terms of the body storage of energy which occurs when they are given to fattening cattle. Only a small number of respiration chambers and calorimeters are available for work with large animals, and the expense and labour involved in their operation limit the number of experiments which can be carried out. Consequently, published values[1] are either the original ones of Kellner[2] or crude estimates based on determinations of digestibility of the feed by sheep.

An attempt has therefore been made to determine indirectly the fat storage of cattle. Protein and ash retention may be estimated by the balance method. The remaining components of a gain of weight of an animal are fat and water, and thus an accurate determination of water retention would permit an estimate of the storage of body fat. The small amount of carbohydrate stored can be ignored. In our hands, water retention could not be accurately computed from determinations of total body water by the antipyrine dilution technique[3] before and after a period of subsistence on a constant diet. Nevertheless, gross changes in the water content of the body over long periods could be estimated in this way, and the method may therefore be used for evaluating the composition of gains in body-weight of cattle at pasture.

A method has now been developed which permits the accurate estimation of water retention from the retention of sodium and potassium. Analysis of the tissues of fœtal, young and mature cattle showed that their water content could be predicted from the equation

$$\text{Water (gm.)} = 0{\cdot}2922\,\text{Na (mgm.)} + 0{\cdot}1471\,\text{K (mgm.)}.$$

This equation was obtained by the method of least squares and applied to organs, tissue fluids and fat depots, varying in water content from 99 per cent (pericardial fluid) to less than 10 per cent (fat depots of mature animals). It also applied to the whole fœtus aged three months, to amniotic fluid and to the ingesta of the rumen, small intestine and cæcum. It did not apply to the contents of the abomasum, presumably due to the high concentration of hydrogen ions. The same equation applied to the tissues of sheep and rabbits. The standard error of estimate of water content was ± 2·0 per cent. Since the equation applied to the individual tissues, it must apply to the animal as a whole and to increments in the growth of the animal, in which water retention may be estimated from the simultaneous retention of sodium and potassium.

The validity of the equation was therefore tested in experiments with growing calves, given daily rations of 1 gallon of cows' whole milk, which permitted a moderate gain of body-weight. The calves were confined in a closed-circuit respiration chamber for periods of eight days, and the storage of carbon, energy, nitrogen, water, sodium, potassium and total ash determined. The storage of water was determined directly from the water intake, the water arising in metabolism as estimated from oxygen consumption, carbon dioxide production and urinary nitrogen excretion, and the excretion of water in the fæces and urine and from the lungs and skin. Water retention was also determined indirectly from the sodium and potassium balances. The results are compared in the accompanying table.

Total Water Balances of Calves during Periods of 8 Days

Calf No.	Days	Total intake of water + metabolic water (gm.)	Water retention determined from balance of intake and excretion (gm.)	Water retention estimated from balances of sodium and potassium (gm.)	Difference (estimated less determined) (gm.)	Difference (estimated less determined) (%)
167	1 + 2		552	547	−5	
	3 + 4		1,136	1,192	+56	
	5 + 6		878	819	−59	
	7 + 8		439	683	+244	
	1–8	37,459	3,005	3,241	+236	+7·85
168	1 + 2		386	740	+354	
	3 + 4		1,217	644	−573	
	5 + 6		690	842	+152	
	7 + 8		992	637	−355	
	1–8	38,566	3,285	2,863	−422	−12·85
169	1 + 2		896	1,096	+200	
	3 + 4		777	1,040	+263	
	5 + 6		1,124	897	−227	
	7 + 8		730	811	+81	
	1–8	37,747	3,527	3,844	+317	+8·99
Complete data		113,772	9,817	9,948	+131	+1·33

The mean discrepancy between the two estimates of water storage for the two-day balances is ± 214 gm. water and is of the same order as that observed for the total eight-day balances. This suggests that the discrepancy arises from the aperiodicity of excretion of water and of sodium and potassium and that the percentage error attached to a gain of water would decrease linearly with length of balance period (cf. the percentage discrepancy for the complete results). There remains the further possibility of reducing the error by smoothing out, by statistical means, the daily variation in excretion of water and of sodium and potassium.

The balance method described, which is independent of the respiration chamber technique and involves only the quantitative collection of urine and fæces, should therefore permit the accurate determination of storage of protein, mineral matter and water by cattle. Since retention of water in the ingesta of the gut is simultaneously estimated by the equation, the error of an estimate of fat retention by difference from body-weight is almost entirely dependent upon the accuracy with which the animal is weighed at the beginning and at the end of the experiment. Diurnal variation in body hydration dependent upon the pattern of water intake and the periodicity of urine and fæcal excretion are important in this respect.

These experiments are being continued and extended, and will be published in detail elsewhere.

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An Action of Strongly Basic Anion-Exchange Resins and Solutions containing Sugars

In view of the expanding use of strongly basic ion-exchange resins in the isolation of plant acids[1,2], a recent experience in this laboratory emphasizes a need for caution in the application of such techniques.

Paper chromatograms, prepared from certain 'acid fractions' of extracts of immature apple fruits, run in butanol – formic acid – water (40 : 10 : 50 v/v), and sprayed with suitable indicator solutions, gave spots for several 'unknown'-acids (R_F 0·24, 0·29, 0·43, 0·50, 0·67, 0·81), the largest spot being at R_F 0·67. The acid responsible for this spot was eventually identified as lactic acid. The 'acid fractions' had been prepared by passing an extract of the fruit, obtained as previously described[2], and freed from amino-acids but containing all the sugars of the fruit, down a column of 'Dowex 2' to absorb the acids, and then fractionally displacing them by means of 0·1 *N* hydrochloric acid.

The apparent isolation of appreciable amounts of lactic acid from fruit which before death had free access to oxygen was surprising, especially since no comparable amounts of pyruvic or other acids associated in metabolism with lactic acid were noted. It was found that if the acids of the apple were isolated by adsorption on, and displacement from, weakly basic resins such as 'Deacidite *E*', no lactic acid appeared.

It is well known that lactic acid is produced when sugars are treated with alkali, and it appeared possible that some at least of the lactic acid obtained arose from the action of the basic 'Dowex 2' resin on the sugars present in the apple extract as they passed down the column. A somewhat analogous case, the hydrolysis of glycosides and disaccharides by strongly acid resins, was studied by Wadham[3]. To test this hypothesis, a solution was made containing glucose, fructose, sucrose, malic acid and quinic acid in roughly the proportions present (6 per cent sugar and 1 per cent total acid) in the amino-acid free apple extracts. This solution was passed down a 'Dowex 2' column and treated in the same way as the apple extracts mentioned earlier. Paper chromatograms were prepared (run in both butanol – formic acid – water, and propanol – ammonia – water, 60 : 30 : 10 v/v) from the original solution and, after concentration to a small volume, from the various fractions displaced from the 'Dowex 2' column with 0·1 *N* hydrochloric acid. In all the first fractions from the column, clear evidence of lactic acid was obtained.

From a comparison of the size of the spots on the various chromatograms, it is certain that at least the greater part of the lactic acid apparently obtained

from the apple was an artefact produced from the sugars present. A little may perhaps have been present in the original extract. Bryant and Overell[1], using the strongly basic resin 'Amberlite IRA 400', obtained traces of an 'unknown' acid from the juice of apples and carrots which had an R_F in butanol – acetic acid – water similar to that of our lactic acid spots. They, however, used the resin in the less-alkaline carbonate form. In our experiments, in which a solution of sugars and acids similar to the one mentioned earlier was passed down 'Amberlite IRA 400 (OH)' in the carbonate form instead of 'Dowex 2', no sign of lactic acid was observed. It appears, therefore, that acids may be adsorbed with safety from plant extracts rich in sugars by strongly basic resins in the carbonate form. In this form, however, the resins have a low capacity, and the concentration of the acid in the solutions passing down them must be very low to prevent evolution of carbon dioxide, with subsequent break-up of the column.

For the separation and isolation of small amounts of acids in the presence of large amounts of other acids, it appears preferable to separate the acids *in toto* from the sugars by a preliminary adsorption on weakly basic ion-exchangers followed by displacement; followed by fractionation on strongly basic anion-exchangers in the 'hydroxyl' form in which they have their highest capacity and resolving power (because of 'tighter' bands) for acids.

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Percentage of Binucleate Cells in the Livers of Adult Rats

Several workers have suggested that the percentage of binucleate cells seen in histological sections is not a true measure of the percentage of such cells in the liver. The cells of the liver are so large, varying between 12 and 25 μ in diameter, that a considerable number of the cells in a section 6–8 μ thick must have been cut through, and in some cases two nuclei may have been separated. Pfuhl[1] corrected for this error in counts made on the livers of rabbits by assuming that the percentages of binucleate cells in sections 5 and 7·5 μ thick were one-third and one-half the absolute value, respectively. Later, Müller[2] elaborated a formula for converting the observed counts to the real percentages. It would be preferable to count the binucleate cells in a suspension of liver cells; but the difficulty has been to prepare a suitable suspension. Recently, Bucher and Glinos[3] reported finding three times as many binucleate cells in a cell suspension as in a section 6–8 μ thick. This suspension had been prepared by agitation of tissue slices in saline (private communication by Dr. N. Bucher).

A simpler method for preparing a cell suspension has now been developed and was used for counting the binucleate cells in the livers of adult male and female hooded rats of the Lister strain. A sample of fresh liver was homogenized for one minute at a low speed in the machine described by Folley and Watson[4] with ten times its volume of the medium described by Robinson[5]. A drop of the suspension so obtained was then mounted and stained with toluidine blue, and the number of binucleate cells in at least 1,000 cells counted. Duplicate counts varied by less than 1 per cent, that is, by less than 3 per cent of their actual value. The results have been listed in the accompanying table together with values for the percentage of binucleate cells in histological sections of livers from rats of similar weight, age and strain. These sections were kindly prepared by Dr. A. M. Barrett, Department of Pathology, Cambridge.

Percentage of Binucleate Cells in the Livers of Adult Male and Female Rats

Sex	Counts made on			
	(*a*) Cell suspension		(*b*) Histological section	
	Weight of rat (gm.)	Binucleate cells (per cent)	Weight of rat (gm.)	Binucleate cells (per cent)
Male	270	32	267	10
	266	30	273	11
	268	29		
	290	29		
Female	202	29	200	11
	220	29	216	12
	235	29		
	200	31		

Some cells were inevitably fractured in the preparation of the suspensions, but these formed only a small proportion of the liver cells, for drops of the suspensions contained mostly intact cells and remarkably little debris. The cells remained intact and separate for at least seven days when the suspensions were stored at 0–2° C. It seems reasonable, therefore, to assume that the mononucleate and binucleate cells had been broken in the same proportion in which they occurred in the liver.

Between 10 and 12 per cent of the cells in histological sections of the livers of both sexes appeared binucleate, in agreement with values reported by earlier workers. It was obvious that many of the cells in the sections had been cut, for all the lobules contained many 'cells' without any nuclei at all. Even though these non-nucleated 'cells' were not included in the counts, the proportion of binucleate cells in the sections was only one-third of that in the cell suspensions. There was no difference between the percentages of binucleate cells in the livers of adult male and female rats: and despite variations in the weights of the rats these values were almost constant at 30 per cent. This figure was required as a step in calculating the chemical composition of the average liver cell[6]; but its agreement with that found by Bucher and Glinos[3] for albino rats is worth recording.

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Composition of Whales' Milk

It has been possible to obtain eight samples of whales' milk for analysis through the very willing co-operation and help of Dr. E. Downing and Mr. J. A. B. Athey, of Chr. Salvesen and Co., Leith, and Dr. J. G. Sharp, of the Low Temperature Research Station, Cambridge. Two of the samples were from blue whales (*Balænoptera musculus*) and the remainder from fin whales (*Balænoptera physalus*). The milks were collected after dissection of the mammary glands during the flensing operation on board Salvesen and Co.'s factory ships *Southern Venturer* and *Southern Harvester* engaged in pelagic whaling in the Antarctic. The period between the death of the whales and the collection of the milk varied from 6 hr. for sample 7 to 19 hr. for sample 4. The samples were stored in glass bottles at a temperature of − 20° C. while on board ship and ashore, before being conveyed to the Hannah Institute with as little rise in temperature as possible. At the Hannah Institute the samples were kept at 4° C. and analysed without delay. Samples 1–3 were at a temperature of − 20° C. for six to seven months and samples 4–8 for two to three months.

It should be noted that the killing of lactating whales, that is, those accompanied by a calf, is illegal and that the samples discussed here were obtained from whales accidentally separated from their calves during the chase or, much more likely, from whales whose young had finished weaning and left their dam. It therefore seems probable, as the data of Mackintosh and Wheeler[4] would also suggest, that the majority of lactating whales caught during the antarctic whaling season (late December – early March) are in the last stages of lactation or in the process of drying-off. Thus the composition of the eight samples obtained may not be typical of normal whale milk; on the other hand, one of Salvesen and Co.'s chemists who has experience of the time when no restrictions on killing were in force, informed me that the percentage of fat in the milk from a whale actively feeding a calf was about 39 per cent—a value similar to the fat content of five of the present samples. Over the four seasons, 1948–49, 1949–50, 1950–51 and 1951–52, the combined catch of the *Southern Venturer* and the *Southern Harvester* was 16,000–17,000 whales, of which only twenty-four were lactating.

Composition of Whales' Milk

Species of whale	Length (ft.)	Date caught	gm./100 gm. milk					
			Water	Fat	Protein (N × 6·38)	Ash	Lactose (by diff.)	Lactose (detd.)
1. Blue	83	24.2.49	45·7	40·0	12·0	1·2	1·1	—
2. Blue	—	10.3.49	48·6	39·1	11·3	1·5	—	—
3. Fin	75	27.2.49	48·1	39·7	11·3	1·3	—	—
4. Fin	77	5.1.52	61·8	18·5	13·1	1·8	4·8	4·5
5. Fin	—	14.1.52	76·2	17·1	3·6	0·8	2·3	0·7
6. Fin	72	27.1.52	38·0	51·0	8·5	0·8	1·7	2·0
7. Fin	68	3.2.52	45·0	37·8	12·1	1·4	3·7	3·6
8. Fin	69	22.2.52	50·0	37·8	10·2	0·8	1·2	1·0
Average composition of milk from Ayrshire cows			87·2	4·0	3·3	0·9*	—	4·6

* By difference; includes approximately 0·2 per cent citrate

The milks were white or very pale cream in colour, had a slight fish-like odour reminiscent of cooked cod-roe and a consistency of thick cream at laboratory temperature; sample 5 had a thinner consistency and sample 4 was very slightly contaminated with blood from an external source. The samples were analysed by the methods usually employed for ordinary milk or concentrated milk products, with small modifications where necessary. The reducing sugar determined in samples 4–8 by a chloramine-*T* potassium iodide oxidation method was assumed to be lactose and was calculated as the anhydrous form. The sugar content of samples 4–7 was determined by Mr. Athey on board the *Southern Harvester* by the same analytical method. His results were not identical with those obtained under the much more favourable conditions at the Hannah Institute, but they suggest that no serious decomposition of lactose occurred during storage, except perhaps in sample 5.

The results in the accompanying table show that whales' milk is much richer in fat and protein and contains less lactose than cows' milk. In these respects, it is similar to the milk of the other cetaceans, the dolphins[1] and the porpoises[2], and also to seals' milk[3]. Rich milk of this type seems to be characteristic of mammals which live in a cold environment and whose young have a rapid rate of growth. The composition of the milk of the two species of whale is very similar; the differences among the samples are probably compounded of lactational effects, individuality and sampling errors, the lactational effects probably being of greatest importance.

With the help of Dr. F. C. Fraser of the British Museum (Natural History) a list of references to literature on the composition of whales' milk has been compiled. None of these reports gives as complete an analysis on as many samples as the present investigation. In general, the results in these publications for milk of several species of whale, including blue and fin whales, are similar to those presented here. Two of the most recent of these reports on whales' milk are by Rowland[5], who analysed three samples of milk from blue whales, and by Pedersen[6], who gives the composition of milk from a humpback whale (*Megaptera nodosa*).

This investigation will be reported in more detail elsewhere, when an account of some minor constituents of whales' milk will be given together with a review of the literature on the milk of this very valuable and largest mammal.

I am much indebted to Chr. Salvesen and Co. and Dr. Downing for the information they have given me about whaling.

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Silver Impregnation of Nerve Fibres

THEORIES of the mechanism of staining of nerve fibres by impregnation with silver solutions have at various times been based on adsorption, and on the stoichiometric combination of the silver and the protein. It seems most probable in the light of recent work on protein – metal complexes[1] that the combination is stoichiometric, and the following investigation appears to support this view.

Spinal cord and sciatic nerve from the frog were fixed in 70 per cent alcohol for three days and then embedded in paraffin wax; sections were impregnated on the slide in a 1/20,000 silver nitrate solution at 37° C. After impregnation, the slides were washed for 5 min. in three changes of distilled water to remove any uncombined silver and were then reduced in sodium sulphite – hydroquinone reducer according to the method of Holmes[2].

When the impregnation was carried out for 17 hr. in silver nitrate solution buffered over the range *p*H 4·0–9·0, it was found that very little silver was taken up below *p*H 7; but above this value the amount increased rapidly to *p*H 9. Since free carboxyl groups are fully ionized at *p*H 6, this suggests that such groups are not the sites of combination of the silver, but rather that some 'weak' grouping is responsible. Even at *p*H 9, silver uptake is small for less than 1½ hr. impregnation, increasing most rapidly between 1½ and 2 hr. This slow reaction also indicates that the combination is due to some weak grouping or to the formation of silver complexes. Any reaction with amino or carboxyl groups would be relatively rapid, as in staining methods using acidic or basic dyes. Attempts were made to block end-groupings in the proteins by using some of the reagents suggested by Danielli[3] and Olcott and Fraenkel-Conrat[4]. The results are indicated in the accompanying table, showing the extent to which the silver impregnation was specific to the nerve fibres and the general level of intensity of the stain at *p*H 9.

	Specificity to the nerve fibre	Intensity of impregnation
Control	++	++
Amino groups		
Nitrous acid	++	+
Formaldehyde	++	++
Picric acid	++	++
Iodoacetic acid	++	++
Carboxyl groups		
Esterification (MeOH + HCl)	+	++
Diazo-methane (in ether)	0	+
Sulphydryl groups		
Iodoacetic acid	++	++
Hydrogen peroxide	++	+
Periodic acid	++	++
Performic acid	+	0(+)
Disulphide linkages		
Thioglycollic acid followed by iodoacetic acid	++	++

Though it would thus appear that carboxyl groups play some part in the silvering process, the slow reaction and incomplete loss of specificity suggest that they are not the actual sites of silver uptake. The possibility of a reaction with aldehyde groupings can be eliminated, since these are not present in alcohol-fixed material[5]; the Feulgen test is, in fact, negative. Extraction of nucleic acids with trichloracetic acid[6] did not affect the impregnation. There remain to be considered the ring-containing amino-acids, tryptophane, tyrosine and histidine.

The specificity of performic acid as a blocking agent for tryptophane (as well as for sulphydryl groups) is useless, as the reagent employed contained a considerable amount of formic acid, which itself greatly reduces the intensity of the impregnation for some reason not known. Of the other two possible reagents, benzoyl chloride and 2.4-dinitrofluorobenzene both greatly reduce staining; the former 'blocks' tryptophane, tyrosine and histidine, the latter blocks tyrosine and to some extent histidine[7]. The fact that staining begins as low as *p*H 7 suggests the combination of silver with the —NH groups of histidine, which has a *p*K value of 6–7 (the *p*K of tyrosine is 10). Silver impregnation of smears of the four proteins

hæmoglobin > fibrinogen > pepsin > protamine

showed a descending order of intensity of impregnation. This order parallels that of their histidine content[8] but not of their tyrosine content.

These results suggest that the silver impregnation of nerve fibres is due chiefly to the combination of histidine groups with the metal and confirms the recent work of Grassman and Kursch[9]. These authors conclude that at *p*H 6·2 the amount of silver combined with proteins of the collagen type is proportional to the histidine content.

I wish to thank Profs. J. E. Harris and J. F. Danielli for their criticism and advice.

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Association of Glucose, Arabinose and Xylose in Jute

THE nature of the association between glucose, xylose and arabinose in the plant is extremely complex. Although a considerable amount of work on glucoxylan or cellulosan[1–7] and xyloaraban or araboxylan[8,9] has been done, the nature of their association has not been definitely established. In some quarters it is believed that the nature of the association between glucose and xylose in the plant might be that of a solid solution type or of mixed crystals[5]. Schmidt[3], Norman[4] and others suggest a chemical combination between glucose and xylose or the presence of cellulosan in the cellulosic materials, whereas Sarkar, Mazumdar and Pal[7] conclude that there is no cellulosan in jute. The present general belief[10] is that association between xylose and glucose is more of a physical than of a chemical nature.

The presence of cellulosan in the plant could not be definitely established due to the failure to isolate simple oligo-saccharides containing glucose and xylose or glucose and arabinose. This seems to be due to the fact that selective hydrolysis had not been tried. Recently, Das, Chaudhuri and Wareham[11] have there-

fore used a weak acid under controlled conditions for hydrolysis of jute holocellulose. This work has been extended by us[12] in hydrolysing the so-called jute α-cellulose, where it has been definitely shown, in contradiction to the finding of Sarkar *et al.*, that α-cellulose invariably contains xylose and that even by fractional hydrolysis pentose-free α-cellulose could not be obtained. Later on, it was found by us that arabinose is also present in jute α-cellulose together with xylose irrespective of the methods of its preparation and even when the last trace of lignin is removed by Norman and Jenkins's method[13].

Like xylose, arabinose also could not be separated from lignin-free α-cellulose even by fractional hydrolysis[12]. This seems to indicate the presence of cellulosan in jute and that the arabinose might be present in pyranose form. This finding, again, cannot be taken as conclusive in establishing the theory of cellulosan, since it is possible that xylan or araban are separate units and that the portion of α-cellulose which was accessible to formic acid was only hydrolysed, so that the association between cellulose and pentosan is only a question of their physical environment rather than chemical union. This is specially so, as it has been shown by Das, Chaudhuri and Wareham[11] by the paper chromatographic method that, in the first hydrolysate (fraction 1) of jute holocellulose, most of the pentosan is hydrolysed but no hexosan.

In order to resolve these conflicting views it was essential, therefore, to follow selective hydrolysis of so-called α-cellulose with formic acid so as to obtain simple oligo-saccharides on the hydrolysate and to identify by paper chromatography the gluco-xylose or gluco-arabinose linkages. For this purpose 1·5 gm. α-cellulose, prepared by treating chlorite jute holocellulose with 17·5 per cent caustic soda as recommended by the American Chemical Society method and modified by Sarkar[14], was hydrolysed with 30 c.c. formic acid (85 per cent) for twelve minutes at 135° C. and the hydrolysate was filtered, made free from acid and decolorized in the same way as done previously[11]. The neutral clear solution was then chromatographed with moist phenol and moist butanol as solvents. Besides the spots of xylose, glucose and arabinose which were isolated and identified in the same way as explained previously, in the case of holocellulose[11] the presence of a new prominent spot in between the spots of uronic acid and glucose has been detected which, however, disappears if the hydrolysis is continued for another three hours. This new complex sugar gives a brownish-pink colour with aniline oxalate spray which is quite distinguishable from the pink colour of xylose and arabinose or the yellow to brown colour of glucose, and travels much slower than maltose but just a little slower than xylotriose. This indicates that the new complex is most probably a triose or tetrose. In order to isolate this complex, the concentrated hydrolysate of jute α-cellulose was chromatographed on Whatman No. 1 filter paper with moist phenol as solvent for ninety hours and the band corresponding to the new spot was cut off. This strip was then extracted with water and evaporated under low temperature and pressure to a small volume. The complex gave only one spot and no trace of any other sugar was obtained even when the chromatograph was run for seventy hours. This was then hydrolysed again for one hour with 85 per cent formic acid at 135° C., the hydrolysate made free from acid, then chromatographed, which shows the spot of the original new complex sugar due to the incomplete hydrolysis and the spots of glucose, xylose and arabinose. The last three sugars were isolated and identified in a similar manner, as explained earlier. It is noticeable that while the parent substance is brownish-pink in colour, its components xylose and arabinose are very bright pink, whereas glucose is only faint yellow, when developed by aniline oxalate reagent.

The above finding conclusively proves the presence of cellulosan, or chemical union between α-cellulose and pentosans. It may be in the form of glucose–xylose–arabinose, glucose–arabinose–xylose or xylose–glucose–arabinose. The above results also suggest a union between xylose and arabinose either with each other or through glucose. This simple oligo-saccharide containing arabinose, xylose and glucose could not be isolated by previous workers probably due to the fact that arabinose generally exists in Nature in furanose form, whereas in this case arabinose seems to be present in pyranose form. Detailed work will be published elsewhere.

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A New Photoperiodic Phenomenon in Short-Day Plants

The classical researches of Hamner[1] on photoperiodism indicated that the flowering of short-day plants, such as Biloxi soybean, is dependent upon exposure to a certain minimum ('critical') dark period. Within certain limits, the length of the critical dark period is largely independent of the duration of the light period, but when the latter reaches 20 hr., flowering in Biloxi soybean will not occur even if the associated dark periods exceed the critical value. The possibility that the length of this limiting light period may vary with the duration of the dark period has apparently never been investigated.

During the course of some recent photoperiodic experiments, it was found that plants of 'Biloxi' soybean flowered when exposed to ten cycles in which the dark periods were of 22 hr. and the light periods of 8 hr. duration, but did not flower when the cycles included 22 hr. of dark and 14 hr. of light. In another experiment with the short-day species *Perilla*

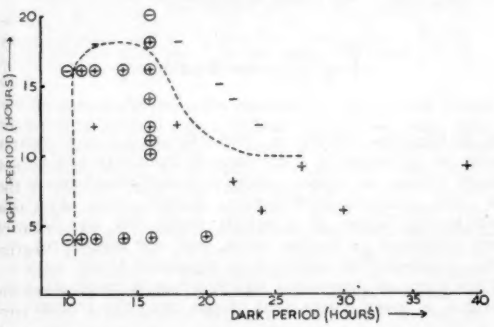
Photoperiod (hr.)	Dark period (hr.)	Number of plants		Mean number of flowering nodes per plant
		Flowering	Vegetative	
6	24	7	0	7·3
6	30	4	3	2·6
6	42	—*	—*	—*
9	27	6	0	4·2
9	39	7	0	5·9
12	12	9	0	12·8
12	18	5	3	1·1
12	24	0	8	0
15	21	0	8	0
18	12	0	9	0
18	18	0	8	0

* Plants died.

ocymoides, it was found that flowering occurred with cycles of 6 hr. light and 30 hr. dark, but not with 12 hr. light and 24 hr. dark. These results suggested that, when the dark period is abnormally long, the length of the associated light periods must be reduced if flowering is to occur.

The following further experiment was carried out with Biloxi soybean in order to investigate this effect in greater detail. All plants were grown under 'long days' until the third trifoliate leaf was expanding and were then exposed to one of eleven different photoperiodic regimes, in which various lengths of dark period ranging from 12 to 39 hr. were used in conjunction with light periods ranging from 6 to 18 hr. (see table). The treatments were carried out in 'growth cabinets' in which lighting was provided by 'daylight' fluorescent lamps giving an intensity of approximately 1,000 foot-candles. The temperature during both the light and dark periods was thermostatically controlled at 21° C. Each treatment was continued for ten cycles, after which the plants were returned to long-day conditions for 16–18 days, when the plants were dissected for observation of flower-initiation. In those groups in which the light periods were of only 6 or 9 hr. duration, a few plants became moribund following the treatment and had to be discarded.

The results are summarized in the table. Maximum flowering occurred with a cycle of 12 hr. light and 12 hr. dark. The flowering response was reduced in all treatments in which the dark period was prolonged beyond 12 hr.; but this effect was much more marked in treatments in which photoperiods of 12 hr. or more were used, and indeed flowering was completely inhibited when light periods of 15 and 12 hr. were used in conjunction with dark periods of 21 and 24 hr. respectively.



Effect of duration of light and dark periods on flowering of Biloxi soybean
+ = flowering. − = not flowering. Points from Hamner's results (ref. 1) enclosed in circles. In drawing the curve, consideration has been given to the magnitude of the positive flowering responses

The accompanying graph has been prepared from the results of the present experiments and from those of Hamner. A curve has been drawn to indicate what appear to be the limiting lengths of light and dark periods for flowering. From this curve it is seen that when the dark period exceeds 12 hr., the duration of the limiting light period falls rapidly to approximately 10 hr. with a dark period of 27 hr. Further extension of the dark period to 39 hr. leads to no further fall in the duration of the limiting light period, however.

The preliminary results obtained with *Perilla ocymoides* described above suggest that a similar effect will be found in that species. Moreover, there is some evidence from the results given by Schmitz[2] that the limiting light period falls in *Kalanchoe blossfeldiana* with a dark period of 32 hr.

An analogous result (though in the reverse sense) was obtained by Claes and Lang[3] with the long-day plant *Hyoscyamus niger*. When this species is grown on a 24-hr. cycle, flowering will only occur if the light period exceeds 10 hr.; but on a 48-hr. cycle, light periods of 9 and 10 hr. are effective in promoting flowering. Thus it appears that the effect observed in soybeans may occur in both short-day and long-day plants.

It is somewhat surprising that this important phenomenon seems to have escaped observation, due apparently to the fact that in past experiments either the dark periods used were not sufficiently long or the accompanying photoperiods were relatively short and did not attain the limiting value. In this connexion, we may note that the duration of dark period necessary to reveal the phenomenon is, in any event, apparently greater in Peking soybean[4] and *Kalanchoe blossfeldiana*[2] than in Biloxi soybean.

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Saprophytic *Cladosporium* in Britain

It has been generally accepted that all the *Cladosporium* which occurs saprophytically in Britain belongs to the ubiquitous species *C. herbarum*. Brooks and Hansford[1] examined many isolates of *Cladosporium* from dead materials and concluded that they were all *C. herbarum*. The list of British Hyphomycetes[2] contains twenty-six names of species of this genus; but Bisby[3] considers the records of only four of these to be valid for Britain, namely, three parasites, *C. pæonia*, *C. fulvum* and *C. cucumerinum*; and one saprophyte, *C. herbarum*.

In investigations of airborne mould spores at this Unit, two distinct types of *Cladosporium* have appeared regularly on Petri dishes exposed to the outside air. Type *A* had branched chains of mainly small spores about 3–7 μ by 3–5 μ, oval or globose, with some larger but more elongate near the conidiophore. The small spores were mainly one-celled and the larger ones frequently two- or more celled. The

spore walls were normally smooth. The macroscopic appearance of these colonies showed considerable variation in texture, colour and amount of sporing, etc., as described by Brooks and Hansford. These colonies were considered to be typical *C. herbarum*.

Type *B* produced large verrucose, oblong spores, mainly 13–19 μ by 7–8 μ, in short branched chains of usually three to five spores. The branches frequently consisted of one or two spores only. About 50 per cent or more of the spores were one-celled and the remainder two-celled, with a small proportion more than two-celled. The colonies were nearly always more woolly than the woolly variants of Type *A*, and the overgrowth of sterile hyphæ was white-grey rather than olive in colour. The features of this mould could not be reconciled with the description of any British species of *Cladosporium*.

The distinction between these two types had previously been noticed by Hyde and Williams (personal communication) in their studies on airborne spores at Llandough Hospital[4]. Through the help of Dr. M. B. Ellis, a culture was examined by Dr. G. A. de Vries at the Centralbureau voor Schimmelcultures, Holland, and identified as *C. macrocarpum* Preuss. This species is recorded by Saccardo[5] from moribund plants in France, Germany and Italy.

On the Petri dishes of Sabouraud's agar exposed daily in this Hospital in a shelter of the Hyde and Williams pattern[6], *C. macrocarpum* is rarely observed during the months October to April, but considerable numbers are seen on the plates during June, July and August. During these months also, about 75 per cent of the whole year's catch of *C. herbarum* appears on our plates. During 1951 from a pair of plates exposed every week-day, 3,047 colonies of *Cladosporium* were counted. Of these, 364 (12 per cent) were *C. macrocarpum* and the remainder *C. herbarum*.

Hyde and Williams find that at Llandough in 1950 the large-spored *Cladosporium* formed about 12 per cent of their total catch of *Cladosporium* (to be published).

In a current investigation, collaborators are exposing Petri dishes of Sabouraud's agar daily at Cambridge, Edinburgh, Llandough, Southampton, London and Liverpool in parallel with our exposures at Cardiff, and returning them to Cardiff for examination. *C. macrocarpum* has appeared on plates from all these places. Dr. P. H. Gregory and Mr. Edward Yuill, carrying out a parallel series of exposures at Rothamsted (Harpenden) and Acomb (York), respectively, have both observed this species on their plates. In view of its widespread and abundant occurrence in Great Britain, it is surprising that there appears to be no previous record of *C. macrocarpum* in the British literature.

These investigations were pursued during my tenure of a full-time research grant from the Asthma Research Council.

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Randomly Stacked Layers in Clay Minerals

Clay minerals having a lamellar structure commonly show a particular type of random stacking, in which only a limited number of definite interlayer spacings exist, but these are distributed with various degrees of randomness. Examples are: mica of 10 A. spacing, with a certain proportion of 14 A. hydrated layers; glycerol-saturated montmorillonite (17·7 A.) in which a certain proportion of layers of lower glycerol content (14 A.) is present; partly dehydrated halloysite[1] (mixture of 10·0 A. and 7·2 A. layers).

It is desirable in such cases to have a means of determining which spacings are present in the mixture, and in what proportions. Formulæ have been derived, enabling the scattering given by random, and partly random, mixtures to be calculated[2]. It is possible, using these, to make a set of curves showing the type of scattering to be expected from various mixtures likely to be met with in practice[3], and these can be used for identifying such mixtures when they occur. However, with mixtures of more than two components, and those which are not completely random but show various degrees of segregation, this method requires the calculation of a very large number of curves. It is therefore very desirable to have a direct method of getting the required information from the measured data.

It has been pointed out by Méring[4] that in principle the Fourier transform of the diffraction diagram gives this information. The transform is difficult to calculate in practice because the totality of the diffraction diagram is not available for study. Generally, the low-intensity regions are masked by the background, and quite often the whole diagram is complicated by the presence of accessory lines, from the same or from different minerals (it is to be remembered that only the part of the diagram arising from the basal reflexions is of interest).

Examination of calculated diffraction curves for mixtures (and of actual diffraction diagrams) shows that the diffraction from such mixtures commonly consists of relatively sharp lines, which, however, do not form an integral series of orders. The information readily available consists of the effective spacings and intensities of these lines. It is possible to show that a Fourier transform may be calculated, using only these data, which will, in general, give the required information. The cosine transform

$$\int_0^\infty \frac{I(\mu)}{\Theta\,|\,F^l\,|^2}\cos 2\pi\mu R\mathrm{d}\mu$$

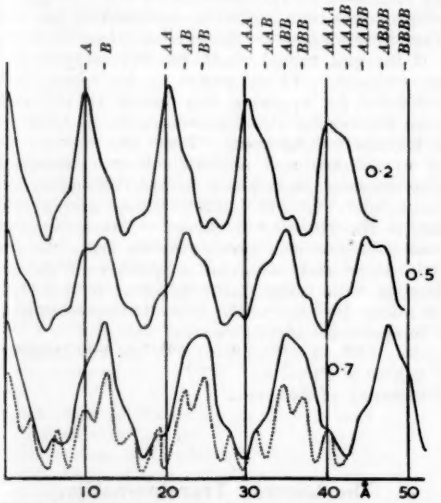
is a function which is proportional to the mean number of layers at a distance R from any arbitrary layer chosen as origin. Here μ is reciprocal spacing, Θ the Lorentz-polarization factor and F_l the scattering factor of a single layer (all the layers are supposed to be the same, and the scattering by the interlamellar material is supposed to be small). This form of function, which gives a peak at the origin, is more convenient to use than the transform of $\frac{I(\mu)}{\Theta\,|\,F\,|^2} - 1$ (James[5], p. 478), which requires a knowledge of absolute intensities.

In the case of a diagram composed of isolated, fairly sharp peaks with reciprocal spacing μ_r and integrated

intensity I_r, we may approximate to the above transform by the sum:

$$\sum_r \frac{I_r}{\theta\,|\,F_l\,|^2}\cos 2\pi\mu_r R.$$

This sum makes use only of the observable data (I_r and μ_r), and has a number of terms equal to the number of lines, and therefore not usually more than ten or so. It seems in general (even when some of the lines are rather broad) to give a very good idea of the composition of a mixture. A test of this is to use the peak positions and intensities calculated by G. Brown and myself[3] for a series of random structures and to calculate the above series for them. The accompanying diagram shows the result for three random mixtures of 10- and 12·4-A. spacings with mica-type layers. The actual value of the spacings and their proportions are well shown, and it is possible from the 'combination peaks' of spacing greater than 12·4 A. to obtain an idea of the degree of randomness of the mixture: the method, which is relatively straightforward, cannot be discussed in detail here.



Calculated series for mixtures of 10 A. and 12·4 A. spacings with mica-type layers. The number attached to each curve gives the proportion of the higher spacing. The ordinates of these curves are proportional to the probability of finding a layer at a given distance from any layer chosen as origin: the (arbitrary) zero level is not shown. The letters indicate the significance of the peaks, *A* meaning a 10 A. spacing, and *B* a 12·4 A. spacing; thus *AAB* is a peak which arises from two spacings of the first type plus one of the second (in any order). The meaning of the dotted curve is explained in the text

The series shown were calculated using only three lines. For such a series diffraction effects may give rise to spurious peaks. These series were therefore calculated after artificially diminishing the high-order terms, and the resulting 'smoothed' series, although not showing spurious peaks to any considerable extent, tends to confuse neighbouring peaks so as to make it difficult to determine the actual spacings present. These can, however, be accurately determined by calculating an 'unsmoothed' series as well; by comparison with the 'smoothed' series the spurious peaks can be readily detected, and the spacings of the genuine peaks measured accurately. The dotted curve in the diagram shows an 'unsmoothed' series corresponding to the lower 'smoothed' curve, and will serve to illustrate the afore-mentioned points.

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Multiple Bursts of Signal in Long-Distance Very-High-Frequency Propagation

DURING the course of recent investigations into the behaviour of radio wave propagation within the 40–60 Mc./s. television band, new phenomena have been observed. For these investigations use has been made, during normal programme hours, of the continuous wave transmission from the B.B.C. television station at Kirk-o-Shotts operating on a frequency of 53·25 Mc./s. (sound), at a distance of 330 miles from the observing station at Great Baddow, Essex.

Normally, a continuous signal of slowly varying amplitude is observed having a mean value of 20 db. below 1 μV./m. but well above narrow-band receiver noise. Superimposed upon this signal is a succession of signal bursts of between 0·1 and 1·0 sec. duration with amplitudes up to 30 db. greater than the mean level of continuous signal; the frequency of occurrence of these bursts varies from about 3 to 20 per min.

Many of these bursts exhibit characteristic Doppler frequency shifts and are identified with meteors and their trails; but among the remaining bursts are many examples of a clearly related pair having a time separation varying from 0·7 to more than 6 sec., this time separation being constant for many pairs over periods of observation of about 15 min. Furthermore, trains of three and four bursts having a constant time separation have also been recorded; the accompanying record shows one such quadruple train, having a time separation of approximately 3·8 sec., in which the bursts occur in descending order of magnitude.

The greatest frequency of occurrence of multiple trains was during the thunderstorm of October 24, 1952, when clear evidence was recorded that separate bursts and pairs of bursts frequently followed a lightning flash. At no time has there been any evidence that succeeding bursts in a train are in any way echoes of the first. Considering that the transmitted signal is an uninterrupted continuous wave, it is suggested, therefore, that the mechanism causing multiple bursts is a relatively local recurrent condition of the medium consequent upon a lightning flash.

It is interesting to recall that T. L. Eckersley has described[1] a peculiar class of atmospheric which he terms a 'whistler'. These whistlers, received by means of a long aerial and an audio-frequency amplifier, are preceded by a click which has since been identified

with a lightning flash. Eckersley furthermore describes trains of whistlers having a time separation of about 3·8 sec. between each succeeding whistler. It seems probable, therefore, that the phenomena of multiple signal bursts and whistlers are closely associated.

A more detailed account of these observations will be published later.

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A Theoretical Model for Arches in the Solar Corona

In recent years, the belief has grown among solar physicists that magnetic fields play an essential part in the phenomena of solar prominences. The study of the static equilibrium of an ionized atmosphere in a gravitational field with some magnetic field also present is expected to shed light on the more difficult dynamical problems, but may also provide models for quiescent prominences, which appear to be almost in static equilibrium. The condition for static equilibrium is that the resultant of the pressure gradient and the gravitational and electromagnetic force densities should vanish.

The simple model has been studied in which (i) the temperature and composition of the atmosphere are uniform; (ii) the gravitational field is uniform, the z-axis pointing upwards; and (iii) the magnetic field is two-dimensional, that is, $H_y = 0$; $\partial H_x/\partial y = \partial H_z/\partial y = 0$; the current density $\mathbf{j}$ then has only a y-component.

The condition for static equilibrium can only be satisfied by magnetic fields for which $\mathbf{j} \exp z/h$ is constant on a line of force, where h is the scale height. Given such a field, the pressure is determined apart from an arbitrary constant. A particularly useful family of solutions is provided by a set of lines of force, such that any magnetic field having these lines of force satisfies the above condition.

These lines of force are the lines of constant F, where

$$F = \exp(-z/h) - 2\exp(-z/2h)\cos(x/2h) + 1 \quad (1)$$

and are shown in the diagram. For $F < 1$, they are closed curves, and the advantage of this family of solutions is that the magnetic field can be taken to vanish outside one of these closed lines of force, so avoiding any difficulty with boundary conditions. The horizontal width of the closed curves does not exceed $2\pi h$.

The effect of the magnetic field on the gas pressure p can be expressed in terms of the magnetic pressure p_H given by:

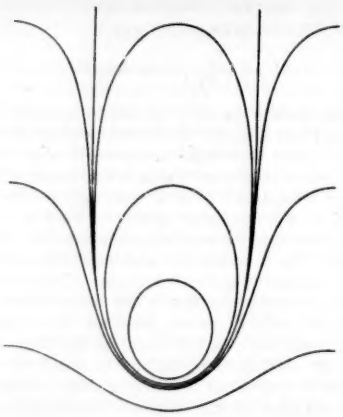
$$p_H = H^2/8\pi. \quad (2)$$

Both $p \exp z/h$ and $p_H \exp z/h$ are constant on a line of force for this family of solutions, and the variation of pressure is given by:

$$\frac{\mathrm{d}}{\mathrm{d}F}\left[\{\exp(z/h)\}(p + p_H)\right] = (-\exp z/h)\, p_H/F, \quad (3)$$

which shows that $(\exp z/h)(p + p_H)$ increases towards the inside of the closed curves.

The two-dimensional form of these solutions makes them appropriate for those prominences which



appear as filaments on the disk of the sun, and the effect expressed by (3) may explain the high pressure of prominences relative to the surrounding gas; but, because prominences are much cooler than the corona, the isothermal model must be seriously wrong in some respects. There seems to be much better justification for applying this model to the arches seen in the corona above prominences, as these may well be nearly isothermal. They are seen in white light at eclipses and are difficult to photograph; but a drawing reproduced in the "Handbuch der Astrophysik", **4**, 200 (1929), shows arches which resemble the theoretical curves. The outer arches appear to be near the limiting width, $2\pi h$; the width of the outer arch is about a quarter of the solar radius, and the temperature required to make these fit is about $10^{6\circ}$ K., which is the accepted value for the temperature in the corona.

J. W. Dungey

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Oct. 2.

The Lorentz Transformation

On the basis of rather less restrictive postulates concerning the behaviour of light than are customary in special relativity theory, Capildeo has recently[1] given the transformation equations

$$\alpha x' = x - Vt, \quad y' = y, \quad z' = z, \quad \alpha t' = t - Vx/c^2, \quad (1)$$

connecting two frames of reference S and S' (with suitably oriented axes) in uniform relative motion, where, it is suggested, the value of α cannot be uniquely determined without additional evidence. If, however, we consider three frames of reference S, S_1, S_2, where the velocities of S_1, S_2 relative to S are V_1, V_2 along Ox, Oy, respectively, then, with the obvious notation,

$$\alpha_1 x_1 = x - V_1 t, \quad y_1 = y, \quad z_1 = z, \quad \alpha_1 t_1 = t - V_1 x/c^2,$$

and

$$x_2 = x, \quad \alpha_2 y_2 = y - V_2 t, \quad z_2 = z, \quad \alpha_2 t_2 = t - V_2 y/c^2,$$

and it will be found after rotating the x-axes of S_1 and S_2 into the direction of their mutual relative

velocity that the new co-ordinates in S_1 and S_2 are connected by equations of the form (1) for all V_1 and V_2 if, and only if,

$$\alpha_i = \sqrt{1 - V_i^2/c^2}.$$

It thus appears that the Lorentz transformation is the only one consistent with Capildeo's assumptions.

In fact, it is possible, using similar reasoning, to derive the Lorentz transformation on very much weaker assumptions which do not involve any assertions about the behaviour of light. Suppose we assume merely that any two frames of reference S and S' in uniform relative motion are connected (with the usual choice of axes) by a transformation of the form

$$\alpha x' = x - Vt, \quad y' = y, \quad z' = z, \quad \gamma t' = t - \mu x, \quad (2)$$

where V is the velocity of S' relative to S according to an observer fixed in S. It then follows, by considering frames of reference moving relative to S in two perpendicular directions as before, that:

(i) $\alpha = \sqrt{1 - V^2/c^2}, \quad \mu = V/c^2,$

where c is an absolute velocity for an observer fixed in S, independent of the magnitude and direction of the relative velocity of S';

(ii) $\alpha/\gamma = c/c' = V/V',$

where c' is the absolute velocity in S' and V' is the magnitude of the relative velocity according to an observer fixed in S'; and

(iii) a velocity c in any direction relative to S is transformed into a velocity c' relative to S'.

Thus (2) represents a Lorentz transformation combined with the introduction of an arbitrary factor in the scale of time in S'; and, in order to obtain the Lorentz transformation exactly, it is necessary to postulate further only that the time-scales in S and S' are such that both assign the same magnitude either to the absolute velocity or to their mutual relative velocity.

A. W. Ingleton

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Malet Street,
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Dec. 29.

[1] Capildeo, R., *Nature*, **170**, 936 (1952).

Exchange of Carbon-13 Dioxide between Calcite Crystals and Gaseous Carbon Dioxide

From previous results[1], it is apparent that considerable exchange occurred between gaseous carbon dioxide and calcite crystals at high temperatures. This effect has been studied further.

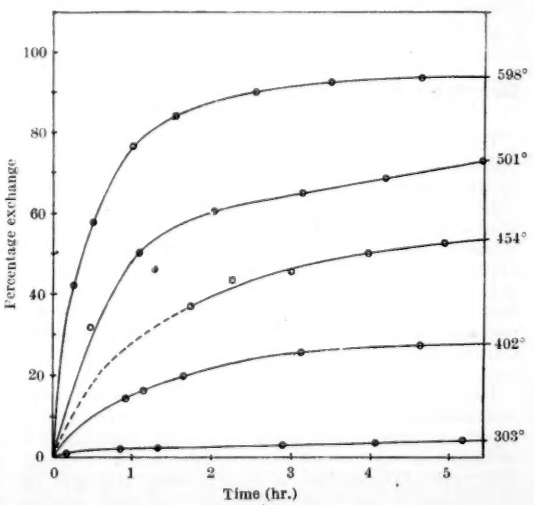
Calcite samples (100 mgm.) of known area were heated in a silica vessel containing enriched carbon dioxide (about 15 per cent $^{13}CO_2$) in the temperature range 300–800° C. The carbon dioxide pressure was at all times maintained well above the corresponding dissociation pressure. The reaction vessel was directly attached to a Consolidated–Nier type mass-spectrometer and the degree of exchange in the crystal was followed by measuring the decrease of carbon-13 in the gas. By a special mixing technique, small representative samples were drawn off and recycled after analysis. Constant temperatures were maintained with an electronic relay and the temperatures were automatically recorded.

It has been reported that, in the presence of water vapour, carbon dioxide exchanges with solid barium carbonate[2]. In the present investigation, with calcite, it was also found that water vapour enhanced the exchange appreciably. Even at room temperature, 3 per cent exchange occurred with the sample of largest surface area. Rigidly dry conditions were therefore maintained in all the experiments reported.

Results indicated that an initial rapid exchange, obviously due to surface and boundary effects, was followed by a slower process. This surface effect was confirmed by measuring exchange at 600° C. on samples prepared by sedimentation of finely ground Iceland spar and on a sample of precipitated calcite ('Witcarb *R*'). The specific surface areas (permeability method) were $5{\cdot}4 \times 10^3$, $3{\cdot}9 \times 10^4$, $10{\cdot}1 \times 10^4$ and $6{\cdot}9 \times 10^5$ cm.$^{-1}$, with a corresponding exchange after five hours of 3, 6, 8·5 and 93 per cent, respectively. Although these results are not quantitatively related, the trend of greater exchange with increasing area is definite. It is known that for larger particles permeability areas may be considerably lower than the reactive surface and, since isotopic exchange between gases and solids is a structure-sensitive phenomenon, discrepancies are to be expected.

Results obtained with 'Witcarb *R*' at temperatures from 300° to 600° C. are presented graphically. The degree of initial exchange increases considerably with temperature, indicating a greater penetration of the crystals. Exchange at 700° and 800° C. was, surprisingly, somewhat lower than at 600° C. (90 instead of 93 per cent). This may, however, be explained by assuming that annealing of the crystals occurs at these temperatures, with a consequent decrease in reactive surface.

For the 303° C. experiment, assuming complete exchange in the surface region and using the surface area determined by Brunauer, Emmett and Teller, it was calculated that a thickness of 2·7 A. was affected. This corresponds to a monolayer and is in agreement with Winter's findings[3] on the exchange between oxygen-18 and aluminium oxide. At higher temperatures, however, the affected thickness is



much larger and the calculation fails, since there is no distinction between an initial surface exchange and exchange within the crystal.

For the investigation of the slower process which succeeded the surface exchange, the sample of specific surface area $5{\cdot}4 \times 10^3$ cm.$^{-1}$ was chosen. This sample gave a readily measurable degree of exchange without being too deeply penetrated, even at high temperatures. The diffusion process could thus be treated as a one-dimensional problem, and a straight line should result when the decrease in carbon-13 dioxide concentration is plotted against the square root of time. Two distinct straight lines were, in fact, obtained, corresponding to the initial surface exchange and to the slower diffusion within the lattice. Diffusion coefficients were calculated from the related curves for 600°, 700° and 800° C. and resulted in values of $2{\cdot}37$, $10{\cdot}8$ and $41{\cdot}7 \times 10^{-17}$ cm.^{2}/sec. This corresponds to a value of D_0 of $1{\cdot}81 \times 10^{-10}$ cm.^{2}/sec. and an activation energy of 27,700 cal./mole, which is 0·67 of the heat of decomposition of calcite.

It appears that exchange may occur by a mechanism in which a carbonate ion momentarily breaks up into a carbon dioxide molecule, leaving an oxygen ion in the site. This carbon dioxide molecule then passes to a neighbouring site similarly vacated and combines with the oxygen ion to reform a carbonate ion. This mechanism is more likely than a process involving the movement of the larger carbonate ions as a whole, since the charge distribution in the lattice remains undisturbed.

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R. A. W. Haul
L. H. Stein
National Chemical Research Laboratory,
J. W. L. de Villiers
National Physical Laboratory,
South African Council for
Scientific and Industrial Research,
Pretoria.
Oct. 8.

[1] Haul, R. A. W., Stein, L. H., and Louw, J. D., *Nature*, **167**, 241 and 727 (1951).
[2] Armstrong, W. D., and Schubert, J., *Science*, **106**, 403 (1947). Yankwich, P. E., *Science*, **107**, 681 (1948).
[3] Winter, E. R. S., *J. Chem. Soc.*, 1170 (1950).

Graphitic Acid from Aromatic Compounds by Peroxide Treatment

Hydrogen peroxide in hot dilute aqueous solution, buffered by dilute acid such as sulphuric or boric acid, in the presence of either cupric or ferric ions, is capable of oxidizing a wide variety of aromatic (and aliphatic) compounds to carbon dioxide and water. Benzene, diphenyl, naphthalene, benzoic acid, toluic acids, phthalic acids, phenols, as well as a considerable number of amino-, nitro-, chloro- and bromo-derivatives of benzene and naphthalene, are all converted to carbon dioxide, water, ammonium salts, nitrate and halide ion in yields approaching 100 per cent under optimum conditions.

During an investigation of the kinetics and stoichiometry of these reactions, it has been observed repeatedly that as the original mixture disappears a transient brown coloration develops in the solution. The typical behaviour is shown when 0·1 gm. of phenol in 20 c.c. of strong solution of boric acid is treated with 5 c.c. of 100-vol. peroxide and 0·1 c.c. of 0·1 *M* copper sulphate solution. When this solution is heated to about 90° C., it rapidly darkens to a dense brown colour, oxygen and carbon dioxide being evolved vigorously. On continued heating, with the addition of further peroxide if necessary, the brown colour fades completely. Considerable variations in the concentrations have little effect on the general changes, although the presence of the trace metal is essential[1].

The brown material is colloidal in nature as indicated by the ultra-microscope and the Tyndall cone; but its coagulation is very difficult indeed. Larger quantities of the material have been prepared by allowing hydrogen peroxide to react with benzene refluxing in a Soxhlet extraction apparatus. In this way the brown material can be prepared dispersed in an organic phase with little inorganic contamination.

Solid samples prepared by evaporation of the benzene had the following analysis: C, 55·91; H, 4·0; O, 40·1 per cent; but no melting point observable. The chemical and physical properties of the material indicate that it is of the same general type as 'graphitic acid'. It is insoluble in inorganic acids and reagents, but is peptized in very dilute ammonium or alkali hydroxide. It is insoluble in the majority of organic solvents, but from either glacial acetic acid or concentrated sulphuric acid (in both of which it appears to disperse) it may be recovered unchanged by evaporation of the acid from a hot slide. There are no detectable functional groups, the only reagents which show the slightest action being powerful oxidizing agents such as acid-permanganate or hydrogen peroxide (130-vol.), in which it dissolves with evolution of carbon dioxide.

Specimens of 'graphitic acid' have been prepared from various specimens of graphite with nitric-sulphuric acid mixtures to which potassium chlorate is added in small quantities over a period of time. The samples are purified by centrifugation and dialysis. The physical and chemical properties of the materials from peroxide appear identical with the standard specimens. Ultra-violet spectroscopy fails to discriminate between the two series. It is hoped to carry out X-ray and thermal analysis shortly.

It is rather difficult to visualize the transformation of benzene into a graphitic acid; but it is presumably via the addition or polymerization of aromatic radicals into the necessary two-dimensional structure between which oxygen atoms are trapped.

The formation of 'graphitic acid' analogues by the peroxide oxidation of aromatic compounds may have connexions with the synthesis of humic acid, peat and coal under natural conditions.

The formation of the brown material from aromatic compounds is not limited to peroxide oxidations. Analogous reactions can be brought about by prolonged anodic oxidation, electrodeless discharge, X-rays or photo-radiation and by various chemical reagents such as persulphate[1]. The parallelism with the hydrogen peroxide process is remarkable, suggesting that the same active entity, OH or HO_2, might be operative in all such cases.

G. A. Bottomley
J. G. Blackman
University of Otago,
Dunedin,
New Zealand.
Oct. 14.

[1] Bottomley, G. A., *Anal. Chim. Acta*, **4**, 566 (1950).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, April 7

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. M. Gordon and Mr. J. S. Taylor: "Recent Advances in the Ionic Reactions of Rubber". (Members of the Institution of the Rubber Industry are invited.)

Wednesday, April 8

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. W. C. Dickerman, jun.: "The Present Status of the Art of Cracking".*

ROYAL STATISTICAL SOCIETY, STUDY SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London W.C.2), at 6 p.m.—Mr. E. Shankleman: Summary of the results of a Survey on the Forecasting of Economic Indices by Economists.

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Lieut.-Colonel J. P. A. Martindale: "Lens Aerials for Centimetric Wave-lengths".

Wednesday, April 8—Saturday, April 11

MATHEMATICAL ASSOCIATION (at the University, Sheffield).—Annual General Meeting.

Thursday, April 9

BONE AND TOOTH SOCIETY (at the Institute of Orthopaedics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Vitamin C and Bone".

SOCIETY OF DYERS AND COLOURISTS (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7.30 p.m.—Mr. J. R. Blockey and Mr. D. H. Tuck: "The Coloration of Leather" (Tenth Mercer Lecture).*

Thursday, April 9—Monday, April 13

BRITISH PSYCHOLOGICAL SOCIETY (at Nottingham).—Annual General Meeting.

Friday, April 10

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the EDUCATION GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. W. Abbott: "The Athlone Fellowship Scheme for the Practical Training in Industry of Canadian Engineering Graduates in Great Britain".

Saturday, April 11

BIOCHEMICAL SOCIETY (joint meeting with the SOCIÉTÉ BELGE DE BIOCHIMIE, in the Faculty of Medicine, The University, 115 Boulevard de Waterloo, Brussels), at 9 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ADVISORY OFFICER IN GRASSLAND HUSBANDRY, and an ASSISTANT LECTURER IN AGRICULTURAL ENGINEERING—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (April 11).

BIOCHEMIST (honours science graduate) primarily for research duties in the Geriatric Department of the Sunderland Hospital group—The Senior Administrative Officer, Newcastle Regional Hospital Board, Blythswood South, Osborne Road, Newcastle-upon-Tyne 3 (April 11).

SENIOR LECTURER or LECTURER TO TEACH ELECTRICAL ENGINEERING to ordinary national certificate and higher national certificate standards—The Principal, School of Electronics, Malvern, Worcs (April 11).

PHYSICIST (Senior Experimental Officer grade) to organize and supervise operations involving processing of radioactive materials, and responsible for accounting and movement control of active materials used by research and development group (Ref. A.68/53A), and PHYSICISTS (Assistant Experimental Officer grade) for radiological work, and for work involving various types of radiation measurement (Ref. A.69/53A), at the Ministry of Supply Establishment, Aldermaston—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (April 18).

CHAIR OF GEOGRAPHY in the University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 25).

LECTURER IN ENGINEERING (with qualifications in civil engineering, and special interests in structures or hydraulics)—The Registrar, The University, Manchester 13 (April 25).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (with university honours degree in science or agriculture or equivalent qualification, proved ability in leadership, and considerable experience in tropical agriculture or field experience in geology, pedology or ecology) to lead a scientific unit that will include a geologist, geomorphologist, pedologist, ecologist, and systematic botanist, to carry out surveys in Papua and New Guinea (headquarters at Canberra)—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 570/23 (April 25).

SCIENTIFIC TECHNICAL OFFICER, Grade II (with a good general training in chemistry, preferably up to degree standard; experience in fuel technology and fuel analysis an advantage), at the Coal Survey Laboratory at Nottingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/612 (April 25).

ASSISTANT LECTURER or LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (April 27).

LECTURER IN ZOOLOGY—The Registrar, Queen Mary College, Mile End Road, London, E.1 (April 27).

ASSISTANT LECTURER IN CHEMISTRY (with a special interest in physical or inorganic chemistry), an ASSISTANT LECTURER IN GEOLOGY, ASSISTANT LECTURERS IN MATHEMATICS (one with special qualifications in applied mathematics), an ASSISTANT LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN PSYCHOLOGY—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (April 30).

ASSISTANT LECTURER or LECTURER IN PURE MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (April 30).

LECTURER or ASSISTANT LECTURER IN ANATOMY—The Secretary of the Medical School, St. Thomas's Hospital, London, S.E.1 (May 1).

DIRECTOR OF THE NATIONAL BOTANIC GARDENS OF SOUTH AFRICA, Newlands, Cape Province—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Newlands, May 15).

ROYAL DUTCH SHELL STUDENTSHIP IN GEOPHYSICS—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (May 30).

MELVILLE TRUST FELLOWSHIPS IN CANCER RESEARCH, tenable in Edinburgh—Messrs. Tods, Murray and Jamieson, W.S., 66 Queen Street, Edinburgh 2 (May 31).

ASSISTANT IN THE DEPARTMENT OF ENGINEERING—The Secretary, The University, Edinburgh (June 1).

ASSISTANT (with degree or equivalent in metallurgy, chemistry, physics or engineering) IN THE INFORMATION DEPARTMENT—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

ASSISTANT CHIEF ENGINEER (Design) to take charge of teams of engineers and draughtsmen engaged on design and detailing of special mechanical and chemical plant—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting 442.

GRADUATES IN MEDICINE OR VETERINARY MEDICINE for postgraduate training in bacteriology and immunology—The Defence Research Member, Canadian Joint Staff London, Moncorvo House, 66 Ennismore Gardens, London, S.W.7, or The Director of Research Personnel, Defence Research Board, Department of National Defence, 'A' Building, Ottawa, Ontario, Canada.

LIVESTOCK OFFICER (with degree in agriculture or related subject with experience of animal husbandry) IN THE VETERINARY DEPARTMENT, Nyasaland—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.67/4/03.

METALLURGIST at the Royal Aircraft Establishment, Farnborough, to work in team engaged on titanium alloy development—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.108/53A.

MICROWAVE AND ELECTRONICS ENGINEER or PHYSICIST (with six to ten years experience) to carry out research and development on guided missiles, a SERVO-MECHANISMS ENGINEER to carry out research and development on guided missiles, an ELECTRICAL ENGINEER or ENGINEERING PHYSICIST (with experience in electronic computation) to carry out development work on aircraft fire control computers, an ELECTRICAL ENGINEER or ENGINEERING PHYSICIST to direct electronic designs and electronic systems production engineering for guided missile development, an ELECTRONIC INSTRUMENTATION ENGINEER to carry out instrumentation work on guided missiles, and MECHANICAL ENGINEERS (with six to ten years experience) to carry out design and development on armament systems—The Defence Research Member, Canadian Joint Staff London, Moncorvo House, 66 Ennismore Gardens, London, S.W.7, or P.O. Box 1427, Quebec City, Quebec, Canada.

PHYSICAL CHEMIST for work on the oxidation of cellulosic materials—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PHYSICAL METALLURGIST (at Sheffield) to carry out research on the ageing of mild steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Ageing of Steel'.

RESEARCH OFFICER (chemist or chemical engineer, with a first- or second-class honours degree or an associateship of the R.I.C.)—The Director, British Paper and Board Industry Research Association, Welcomes Road, Kenley, Surrey.

SOIL PHYSICIST (with good honours degree in physics or chemistry, including physical chemistry, with at least two years postgraduate experience or training in soils physics)—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27106/52.

SPECIALIST TECHNICAL EDITOR (with honours degree in mathematics, physics or engineering and ability to deal with mathematics up to at least degree standard) in the Ministry of Supply, Chessington, to prepare instructional text-books on guided weapons, involving collation of information and editing contributions—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.76/53A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Science and Wool. Pp. 36. (London: International Wool Secretariat, 1952.) 2s. net. [11

Agricultural Research Council. Quantitative Inheritance: Papers read at a Colloquium held at the Institute of Genetics, Edinburgh University, under the auspices of the Agricultural Research Council, April 4th to 6th, 1950. Edited by E. C. R. Reeve and C. H. Waddington. Pp. 151. (London: H.M. Stationery Office, 1952.) 20s. net. [11

Bulletin of the British Museum (Natural History). Entomology. Vol. 2, No. 6: A Review, and a Revision in the Greater Part, of the Cteniscini of the Old World (Hym., Ichneumonidæ). By G. J. Kerrich. Pp. 305–460+plates 4–7. (London: British Museum (Natural History), 1952.) 30s. [11

General Register Office. The Registrar General's Quarterly Return for England and Wales. No. 415: Births, Deaths and Marriages, Infectious Diseases, Weather, Population Estimates: Quarter ended 30th September 1952. Pp. 28. (London: H.M. Stationery Office, 1952.) 2s. 6d. net. [131

University of Leeds: The Brotherton Collection. Seventeenth Annual Report of the Brotherton Collection Committee, Session 1951–52. Pp. 10. (Leeds: The University, 1952.) [131

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 65, Part 1, No. 1: New Records of Sub-Littoral Polychætes from the Clyde Sea Area, with a Description of a New Species. By R. B. Clark. Pp. 26. 4s. 6d. Vol. 65, Part 1, No. 2: Note on the Evolutionary History of the Paired Fins of Elasmobranchs. By Miss A. E. Miller. Pp. 27–35. 1s. 6d. Vol. 65, Part 1, No. 3: A Genetical Basis for the Classification of Strains of *Phytophthora infestans*. By Dr. Wm. Black. Pp. 36–51. 3s. Vol. 65, Part 1, No. 4: Longtime Trends in Egg Production in a Closed Line of Fowls. By Dr. J. S. S. Blyth. Pp. 52–65. 2s. 6d. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) [131

National Museum of Wales. Forty-fifth Annual Report, 1951–52. Pp. 34+4 plates. (Cardiff: National Museum of Wales, 1952.) [131

Royal Photographic Society of Great Britain. Library Catalogue, Part 2: Subject Catalogue. Pp. iii+105. (London: Royal Photographic Society, 1952.) [131

Linen Industry Research Association. Report of the Council, 1952. Pp. 24. (Lambeg: Linen Industry Research Association, 1952.) [131

Ministry of Agriculture and Fisheries. Bulletin No. 38: Sex-Linkage in Poultry Breeding. By Michael Pease. Pp. iv+11+4 plates. (London: H.M. Stationery Office, 1952.) 3s. net. [131

British Chemicals and their Manufacturers: the Directory of the Association of British Chemical Manufacturers. Pp. 179. (London: Association of British Chemical Manufacturers, 1953.) Free. [141

Royal Technical College, Glasgow. Report on Research, Session 1951–52. Pp. 36. (Glasgow: Royal Technical College, 1952.) [141

Department of Scientific and Industrial Research. A Survey of Production and Industrial Engineering Organisation and Practice in the U.S.A. and Canada. By T. G. Elliott. Pp. 32. (London: H.M. Stationery Office, 1952.) 1s. net. [141

Royal Doulton Potteries. Pp. 52. (London: Doulton and Co., Ltd., 1953.) [141

Progress Reports from Experiment Stations, Season 1951–52. Aden Protectorate. Pp. ii+5. Anglo-Egyptian Sudan. Pp. ii+21. Cotton Research Station, Namulonge, Uganda. Pp. ii+35. Nyasaland. Pp. ii+7. (London: Empire Cotton Growing Corporation, 1952.) 9d. each. [191

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 25: Rear Lights of Motor Vehicles and Pedal Cycles. By R. L. Moore. Pp. vi+21+6 plates. (London: H.M. Stationery Office, 1952.) 1s. 6d. net. [191

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